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SCIENCE ABSTRACTS

SECTION A.—PHYSICS.

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ABSTRACTORS

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F. S. Barton, M.A., B.Sc.
E. Bellini, D.Sc.
W. G. Bickley, M.Sc.
H. Borns, Ph.D.
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C. B. Clapham, B.Sc. (Eng.).
L. M. Clark, Ph.D.
B. W. Clarke, B.Sc.
A. E. Clayton, D.Sc.
A. Daniell, M.A., D.Sc.
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E. Foord.
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E. Griffiths, D.Sc.
W. H. Grinsted.
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T. C. Harrison, A.M.I.E.E.
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L. F. Mountfort, A.M.I.E.E.
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J. W. T. Walsh, M.A., M.Sc.
A. Whitaker, M.A.
A. Wilkinson, B.Sc.
A. B. Wood, D.Sc.

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SCIENCE ABSTRACTS.

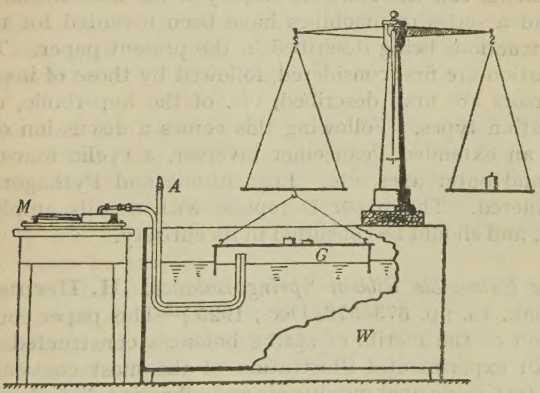
Section A.—PHYSICS.

APRIL, 1926.

GENERAL PHYSICS.

659. *Standard Time throughout the World.* (Bureau of Standards, Circ. No. 280. [9 pp.], 1925.)—This paper gives a brief historical sketch of the development of the standard time system, a map showing the time zone boundaries in the United States, and a list of the official stations sending out radio time signals. Time in nearly every foreign country is also given, compared with both Greenwich mean time and with noon, eastern standard time.

660. *Calibration of a Micromanometer.* **F. Levy.** (Zeits. Instrumentenk. 45. pp. 515-521, Nov., 1925.)—Describes a simple method for calibrating micromanometers. A U-tube from the manometer, and a U-tube for the introduction of air are arranged to give access to the air enclosed



in a miniature diving-bell (see fig.). The weight of this bell in the position of atmospheric pressure inside is balanced, and weights are then added to the bell, and air is introduced to give any desired internal pressure. This internal pressure can be calculated accurately from dimensions, and compared with the reading of the manometer. J. W. T. W.

661. *An Electrically-controlled Micrometer Caliper.* **C. Moon.** (Optical Soc. America, J. and Rev. Sci. Inst. 11. pp. 453-458, Oct., 1925.)—A

description of a special micrometer caliper fitted with electrical control for remote operation. The headstock and tailstock are supported by a heavy ring frame. The headstock screw is driven by a very small electric motor, and in the tailstock there is a mechanism which automatically stops the motor by opening a set of electric contacts when the critical measuring pressure is reached. The caliper was designed for the purpose of measuring the diameter of a precision single-layer inductance coil while both coil and caliper were in a constant temperature enclosure. E. G.

662. *Automatic Recorder for Measuring Size-frequency Distribution of Grains in a Sedimenting Liquid.* **R. H. Lambert** and **E. P. Wightman.** (Eastman Kodak Co. Research Lab. Comm. No. 244. Optical Soc. America, J. and Rev. Sci. Inst. 11. pp. 393–402, Oct., 1925.)—The paper describes a simple automatic photographic method for determining weight or size-frequency distribution of particles in a sedimenting liquid. A method of correcting an important error in the Oswald-Hahn, Kelly sedimentation process has been worked out. This error is due to a lag in flow of liquid in the side arm of the sedimentation apparatus caused by viscosity. A method of calibrating the instrument has been employed which eliminates other sources of error and shortens the process of conversion of the data. An approximate, rapid method of making the corrections for lag in the initial portion of the sedimentation record has been suggested. This consists in drawing a tangent to the ordinates of the observed curve through the known point at which sedimentation begins. E. G.

663. *Inversors.* **O. v. Gruber.** (Zeits. Instrumentenk. 45. pp. 561–573, Dec., 1925.)—The name " Inversor " is used to designate mechanical contrivances which serve for the representation of reciprocal relationships. Such instruments can therefore be employed for the solution of the lens equation, and a series of machines have been invented for this purpose, typical constructions being described in the present paper. The forms of the lens equation are first considered, followed by those of inversors. The known inversors are first described, *viz.* of the hyperbolic, cyclic, lever, and combination types. Following this comes a discussion of new possibilities, *e.g.* an extended Peaucellier inversor, a cyclic four-disc inversor with inner and outer axes, etc. Logarithmic and Pythagoras types are finally considered. The paper is replete with details amply illustrated by diagrams, and should be consulted in its entirety. H. H. Ho.

664. *The Extensible Ribbon Spring Balance.* **H. Hermann.** (Zeits. Instrumentenk. 45. pp. 573–576, Dec., 1925.)—This paper contains a very full discussion of the merits of spring balances constructed of long steel ribbons, with experimental illustration of the most convenient form to adopt as protection against moving air and vibration disturbance. Experimental data are also included to show how far the present accuracy attained confirms the Coulomb law. H. H. Ho.

665. *" Pangrafics."* **C. Dévé.** (Rev. d'Optique, 4. pp. 568–574, Nov., 1925.)—This paper contains a detailed description of the construction of modified pantographs termed " pangrafics," which are particularly suitable for engraving tiny inscriptions on glass or for ruling and figuring graticules. A. W. L.

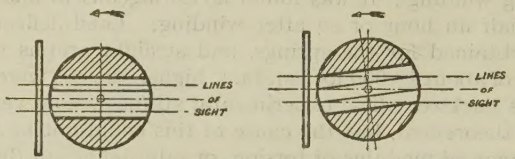
666. *Phosphor-bronze Helical Springs from the Standpoint of Precision Instruments.* **W. G. Brombacher.** (Optical Soc. America, J. and Rev. Sci. Inst. 11. pp. 519–547, Nov., 1925.)—This paper is the record of work undertaken to obtain knowledge of the properties and performance of helical springs which might be useful in the design of precision instruments. So far, only phosphor-bronze springs have been considered. Nomograms (one embodying a new principle by which a pair of dividers replaces the straight edge) were prepared from the theoretical formulæ for the number of turns for a required stiffness with given radius of coil and diameter of wire, and for the maximum stress, and they are reproduced. The modulus of torsion of the wires used was measured by a dynamical method. Springs were made with various thicknesses of wire and coil radii to various designed stiffnesses, not less than three of any one design. To avoid end effect, the ends were screwed on brass plugs threaded to the pitch of the springs. The springs were wound on an arbor in a lathe, and the wire was kept under tension during winding; it was found advantageous to allow the load to stay on for half an hour or so after winding. Load-deflection measurements were obtained for the springs, and straight graphs were obtained up toa stress of about 18,000 lbs.-sq. in.; higher stresses were not reached, as the springs buckled. The experimental stiffness, however, was always less than the theoretical, but the cause of this could not be traced to end effect, inaccuracy of modulus of torsion, or internal strain (heat treatment producing no appreciable change of stiffness). Hurlbrink's criterion for buckling, $B=45r^2/hD$ (in which r=coil radius, h=length and D=deflection), $B \geqslant 6$, was found to be in fair agreement with the more accurate results (difficulty in centering the load being encountered), but it is suggested that 6 be replaced by 10. Hysteresis was present to a slight extent, and "seasoning" by repeating the cycle many times did not appreciably affect it. Drift, or change in deflection with time when kept under load, seemed to be about 0·2 % for one hour for all springs, and Hersey's suggestion that it varies as the cube root of the time was borne out in one instance where the load was kept on for seventeen hours. A bibliography is appended. W. G. B.

667. *Silica to Glass and to Metal Joints.* **L. J. Buttolph.** (Optical Soc. America, J. and Rev. Sci. Inst. 11. pp. 549–557, Nov., 1925.)—The author outlines various practical methods of joining silica to common glass and to metal. [See Abstracts 2 and 1347 (1924).] It is pointed out that fine W and Mo wires may be sealed directly into silica and also several such wires in parallel. Joints by Kraus, Sands, Devers, and others are described. Hulbert has described a method of sealing silica to glass by the use of silver chloride as a cement. Keyes-Kraus graded joints are described, and photographs of examples given. For details the original should be consulted. W. V. M.

668. *Properties of the Alkali Metals.* **P. W. Bridgman.** (Am. Acad., Proc. 60. pp. 385–421, Oct., 1925.)—The following properties of rubidium and cæsium have been measured over a wide range of pressures: compressibility, change of volume on melting, variation of melting-point with pressure, and electrical resistance. The specific resistance of potassium has been redetermined with samples of bare potassium wire at various pressures, and results previously obtained are found to have been in error. The properties of potassium are anomalous, and suggest that this metal

may have a polymorphic modification at high pressures. The resistance of cæsium passes through a minimum with increasing pressure, and this phenomenon is held to support the view that the conduction electrons are constrained to move in guided tracks through the metal. C. W. H.

669. *The Ashdown Rotoscope.* (Journ. Sci. Instruments, 3. pp. 15–20, Oct., 1925.)—This is an apparatus for the investigation of rotating and periodic movements. It comprises a rotary shutter in the shape of a small cylinder, which is made to rotate at a controlled speed in front of the eyes and through which are cut two slots, one for each eye. Thin slats parallel to the axis of the cylinder are fixed in the slots. As the observer looks through the shutter, the object to be examined becomes visible at the full aperture of the slots for an extremely brief period twice in each revolution of the cylinder, and the view is then cut off by the slats (see fig.). The period of visibility is from 1/5000th to 1/20000th part of



a second. A number of interesting applications are cited. For a high degree of speed control an electric motor is used, but the industrial model described in the article is driven by clockwork. A five-step gear and an adjustable governor serve to control the speed. The instrument weighs about 7 lbs., is compact and easily portable. W. H. G.

670. *Viscosity and Chemical Analogy. Metallic Acetates in Aqueous Solution.* **L. J. Simon.** (Comptes Rendus, 181. pp. 862–864, Nov. 30, 1925.)—Continuing on the lines of previous studies [see Abstract 1655 (1924)], experimental determinations are made of the viscosities of series of aqueous solutions of KHO and NaHO respectively, mixed in varying proportions with organic acids, as CH_3CO_2H, HCO_2H, $C_2H_5CO_2H$, and CCl_3CO_2H. In the case of CH_3CO_2H, with either alkali viscosity bears linear relationships with acid concentration throughout the series, no indication corresponding to salt formation being observed. With the other acids, both alkalis yield series presenting linear relationships up to the point corresponding to exact neutralisation, from whence a new linear function is established. In the case of $CH_3CH_2CO_2H$ the viscosity at neutralisation point with either alkali is less than the average viscosity of the mixtures; with the other acids it is greater. Viscosity in aqueous solution is regarded as a valuable means of revealing or confirming chemical analogy. A. B. C. L.

671. *Resistance to Stretching of Vulcanised Indiarubber.* **R. Ariano.** (N. Cimento, 2. pp. 415–437, Oct.–Nov.–Dec., 1925.)—In addition to establishing the relation between strains and deformations in the case of stretching, the object of this paper is to find the type of function to replace the constants of Young and Poisson and the expression for the work of deformation. Compression will be discussed in another paper. The

problems are treated mathematically and the results shown in four tables and six curves. E. F.

672. *Efflux of Plastic Substances.* **B. Marzetti.** (Accad. Lincei, Atti, 2. pp. 169–173, Sept., 1925.)—In a previous paper it has been shown that for unvulcanised rubber Poiseuille's law does not hold, the efflux over a considerable range being proportional to the square of the pressure. In this paper is investigated how far this quadratic relation applies. In the case of a 1 : 4 solution of rubber in benzene Poiseuille's law holds, but a 1 : 2·34 solution obeys the quadratic relation. A more satisfactory solvent for the more accurate work is a heavy mineral oil, and a table is given comparing the rates of efflux under different heads of a rubber oil mixture of the proportions 1 : 17 and a castor oil of the same order of viscosity. The castor oil obeys Poiseuille's law, while the rubber mixture departs from it to an even greater extent than is indicated by a quadratic expression. There is approximate linearity in the lower range of pressures. The type of motion as judged by inspection of minute floating particles is a stream-line one, with the axial part moving with an increasingly high velocity as the pressure rises. The effect seems to be explainable in terms of a reduced viscosity for high rates of shear. A. Wh.

673. *On the Elastic After-effect at Different Temperatures.* **H. König.** (Phys. Zeits. 26. pp. 797–811, Dec. 16, 1925.)—In this paper a simple apparatus is described for investigating at different temperatures the elastic after-effects of thin bars, and experimental results are given for amorphous (glass) and crystalline (copper, brass, aluminium) materials at temperatures between 15° and 360°. It was found that in general the after-effects expire more rapidly than in proportion to the logarithm of the time, but slower for glass between 150° and 250°. Over long periods this law holds good only at certain temperatures. The formulæ associated with the loading curves are found to require certain modifications, while the unloading curves derived from them are found to be somewhat flatter than the experimental ones. The temperature dependence of the elastic after-effect is greater for the metals than for glass, and especially so for the alloy brass, where the increase of deformation in a temperature region around 300° was about a hundred times that at 16°. For metals there is always increase with temperature, but for glass a decrease occurs between 150° and 250°, followed, however, by a remarkable increase whereby the value of the after-effect at 360° was found to be double that at 300°. At the higher temperatures the so-called *accommodation* comes into prominence. The elastic after-effect was also found to be very much dependent on previous treatment, heating, for example, producing a diminution in the amount, and drawing causing copper to exhibit a very complex behaviour. The paper is replete with data. H. H. Ho.

674. *The Kinetic Theory of the Compressibility of Solutions and Binary Liquid Mixtures. II.* **K. C. Kar.** (Phys. Zeits. 26. pp. 737–739, Dec. 8, 1925.)—In Part I the author has deduced certain formulæ, which are experimentally confirmed [Abstract 2206 (1925)]. He here shows that the formula for solutions agrees with the empirical formula of Gilbault, and verifies the theoretical formula by considering a number of additional salt solutions. The compressibility of mixtures of alcohol and water and of alcohol and carbon bisulphide is considered in Part I, while in the

present paper chloroform-carbon bisulphide and water-acetic acid are dealt with. In the latter case, where the components mix, the observed and the theoretical values of the compressibility differ considerably from one another from concentration 20 to 60. This is easily understood when it is remembered that the formula only holds for dilute solutions. H. N. A.

675. *Flow of Air round Aerofoil of Infinite Span.* **L. W. Bryant** and **D. H. Williams.** *Connection between Lift and Circulation.* **G. I. Taylor.** (Roy. Soc., Phil. Trans. 225. pp. 199–245, Nov. 6, 1925.)—Describes a detailed exploration of the field of flow around an aerofoil of fairly high lift coefficient. The method of making the measurements (which were carried out in the 14 × 7-foot tunnel at the National Physical Laboratory) is described in the paper. The results are tabulated and exhibited graphically. The theoretical stream-lines were calculated on the assumption of a circulation corresponding in magnitude to that found experimentally. The experimental front stagnation point coincides satisfactorily with that found by theory. The rear stagnation point is indeterminate. The law of Kutta and Joukowsky is verified, that the product of the mean velocity and density of the fluid and of the circulation around a contour enclosing the aerofoil is equal to the lift. The circulation is constant within the experimental limits, and is independent of the contour of integration chosen, provided this does not approach the aerofoil too closely and provided it cuts the trailing " wake " approximately at right angles to its core.

The note by **G. I. Taylor** is theoretical, and shows that the relation between circulation and lift must hold very closely, even in the extreme case of discontinuous motion, provided the contour is large and cuts the wake in a straight line perpendicular to the direction of motion of the aerofoil. J. W. T. W.

676. *Fundamental Equations of Quantum Mechanics.* **P. A. M. Dirac.** (Roy. Soc., Proc. 109. pp. 642–653, Dec. 1, 1925.)—A purely mathematical discussion on the lines of Heisenberg [Abstract 45 (1926)]. The relations and distinctions between the ordinary algebraic operations and those developed in this quantum system are described. A. Wh.

677. *On the Hypothesis of Equal Distribution.* **G. Jaffé.** (Phys. Zeits. 26. pp. 752–754; Disc., 754–755, Dec. 8, 1925. Paper read before the Deut. Physikertag., Danzig, Sept., 1925.)—The proof of the equal distribution hypothesis has only been rendered for quasi-ergodic systems, *i.e.* such systems in which the assumption is made that every phase of motion is compatible with given energy values. The essential character of this assumption is that only the idea of constant energy is considered quite apart from the possible existence of other invariants of motion. The author now defends the standpoint that such preferential treatment of the energy integral is inadmissible, and gives examples to show that on a wider consideration of the integral of motion the general validity of the equal distribution hypothesis is lost. [See Abstract 2897 (1924).] **Smekal, Sommerfeld** and **Herzfeld** took part in the discussion.

H. H. Ho.

678. *The Crystalline Structure of Metals.* **J. H. Andrew.** (Roy. Techn. Coll., Glasgow, J. No. 2. pp. 63–69, Dec., 1925.)—This paper deals

with some of the more theoretical aspects of the relation between crystalline structure and the physical properties of metals and their alloys. Problems concerned with the atomic structure of the crystal, and the grain boundaries in a multi-crystalline substance are discussed. AUTHOR.

679. *X-Ray Examination of Inner Structure of Strained Metals. IV. α-Iron plastically strained in Extension, Compression and Torsion.* **A. Ono.** (Kyushu Univ. Coll. Eng., Mem. 3. 6. pp. 267–286, 1925.)—The general procedure of analysis of the X-ray diffraction figure was described in the third report of this series. In the present report it is explained that the inner structure of strained metals is statistically equivalent to two kinds of symmetry models, which are classified according to the regularity of the crystal rearrangement. The X-ray examination of α-iron plastically strained in extension, compression and torsion was worked out by taking the diffraction figures of the specimens from the strained metal in various directions. The patterns of extension and compression specimens were analysed and explained by reference to the two kinds of model structures. The pattern of torsion specimens was also explained by referring to one of the models. The particulars of the model structures are as follows :—

	Lattice Axis rearranged in Axial Direction of Test Piece	State of Arrangement.	Kinds of Symmetry.
Extension ..	[110]	Deviating	Second kind [001] in lateral direction
Compression	[111]	Fairly regular	First kind
	[100]	Deviating	Second kind [011] in lateral direction
Torsion	[110] and [121]	Deviating	Second kind [111] in tangential direction

A. B. W.

680. *The Lattice Parameter and Density of Pure Tungsten.* **W. P. Davey.** (Phys. Rev. 26. pp. 736–738, Dec., 1925.)—Because of the importance of knowing the values of these constants as accurately as possible, X-ray diffraction patterns were made for several samples differently treated as follows : (1) W plus 10 parts flour in comparison with NaCl in the other end of specimen tube ; (2) the same in comparison with Au plus 10 parts flour ; and (3) W plus 10 parts NaCl. The results agree within the reproducibility of the results, 0·001 to 0·003 Å., with the values previously obtained for lattice parameter ($a = 3{\cdot}155 \pm 0{\cdot}001$) and density ($D = 19{\cdot}32 \pm {\cdot}02$). AUTHOR.

681. *Physical Properties of Single Crystals of Tungsten, Antimony, Bismuth, Tellurium, Cadmium, Zinc and Tin.* **P. W. Bridgman.** (Am. Acad., Proc. 60. pp. 305–383, Oct., 1925.)—The author describes the method employed for growing large crystals in moulds of glass, and the measurement and computation of their thermal expansion, specific resistance, and elastic constants in different directions. Sb, Bi and Te are

trigonal, Cd and Zn hexagonal, and Sn tetragonal, while tungsten is cubic. The surfaces of the crystals were covered with very minute pits, whose sides are the plane faces of the natural crystal; these planes reflect a parallel beam of light in definite directions, and this makes it possible to decide whether the casting is formed of a single crystal or not and to determine the orientation of the axes; the method is much more convenient than the X-ray method. A table gives the initial linear compressibility at 30°, the elastic constants s_{11} and s_{33}, linear thermal expansion at 20° C., specific resistance at 20° C., average temperature coefficient of spec. res. 0°–100° C., and the initial pressure coefficient of spec. res. parallel and at right angles to the axis of three-, four- or six-fold symmetry. Pressures up to 12,000 kg./cm.^{2} were employed and a number of interesting results were obtained. Tellurium showed negative expansion and compressibility along the axis; the change of resistance of antimony perpendicular to the axis is anomalous, since at 50° C. the resistance increases with increase of pressure, but it passes through a maximum and then diminishes; there is evidence of two new high-pressure modifications of cadmium. The cleavage plane or plane of easiest slip where there is no cleavage is distinguished by the fact that the atoms are connected more loosely across it than in other directions. The effective Young's modulus is greatest across this plane except in Sn; the thermal expansion is also greatest in this direction and the specific resistance except for Sb. H. N. A.

682. *Linear Compressibility of Fourteen Natural Crystals.* **P. W. Bridgman.** (Am. J. Sci. 10. pp. 483–498, Dec., 1925.)—The linear compressibility was measured by the method previously described at 30° and 75° in the pressure range 0 to 12,000 kg./cm.^{2}; for the non-cubic crystals measurements were taken in several directions so that the cubic compressibility could be calculated. For all the crystals except quartz the relation between pressure and change of length can be represented by a second degree equation. Compressibility is, in general, less at high temperatures. With quartz the compressibility increases with increasing pressure above 8000, and the compressibility of the crystals is initially greater than that of quartz glass; at high pressures the relative magnitude of the compressibilities is reversed. The ratio between the linear compressibilities along the axis is not connected with the axial ratios; when one of these ratios is large the other may be small. Pressure may tend to alter the axial ratio towards unity, and it is possible that a non-cubic crystal might become temporarily cubic for a certain pressure when Neumann's law would fail for that pressure. At 30° C. and above 9000 kg./cm.^{2} argentite and sphalerite probably undergo a polymorphic transition. H. N. A.

683. *Crystal Structures of Sodium and Potassium Trinitrides and Potassium Cyanate: Nature of the Trinitride Group.* **S. B. Hendricks** and **L. Pauling.** (Am. Chem. Soc., J. 47. pp. 2904–2920, Dec., 1925.)—The densities of sodium and potassium nitrides, measured by the Retgers suspension method, are 1·853 and 2·038 gr. per c.c. respectively. The rhombohedral structural unit of sodium trinitride has $\alpha = 38°43'$ and $a = 5·481$ Å., and contains 1 NaN_3, whilst the tetragonal unit of potassium trinitride has $a = 6·094$ Å. and $c = 7·056$ Å., and contains 4 KN_3. The structure of potassium cyanate closely resembles that of the trinitride, the unit of structure having $a = 6·070$ Å and $c = 7·030$ Å.

Neither sodium nor potassium trinitride exhibits molecular segregation, but the trinitride ion is easily distinguished. This ion is shown to possess, not a ring structure, but a linear arrangement of the three atoms; the possible electronic configurations are discussed. The results previously obtained for sodium and potassium hydrogen fluorides indicate that the hydrogen fluoride ion is similar in structure to the trinitride and cyanate ions. T. H. P.

684. *Röntgenographic Determination of the Atomic Arrangement in the Mixed Crystal Series Au–Cu and Pd–Cu.* **C. H. Johansson** and **J. O. Linde.** (Ann. d. Physik, 78. 5. pp. 439–460, Dec., 1925.)—The paper commences with a discussion of previous work, no single conception being held with respect to the constitution of mixed crystals. [See Abstracts 2356 (1924) and 1684 (1925).] The investigation then described deals with the series Au–Cu and Pd–Cu, which are particularly suitable for the determination of atomic arrangements. A parallel investigation of the electric conductivities of the alloys used has also been made. The materials and experimental details are very fully described. The lattice types of the compounds Cu_3Au and CuAu have been established, and also the conclusion drawn that in mixed crystals a Tammann arrangement is not usually found. An increase of conductivity is also found to be related to an atomic arrangement, and support thereby given to Højendahl's theory of electrical conduction in mixed crystals. [See Abstract 2835 (1924).] The paper is replete with diagrams and experimental data.

H. H. Ho.

685. *Influence of Molecular Structure on the Dipolar Character of Isomeric Ethylenes. Calculation of the Molecular Moment.* **J. Errera.** (J. de Physique et le Radium, 6. pp. 390–396, Dec., 1925.)—A study is made of the influence of molecular structure on specific inductive capacity. Experimental results are given in the case of ethylene derivatives carrying two positive groups and two negative groups, the different isomers corresponding to the different arrangements of these groups. Employing the Langevin-Debye formulæ regarding dilute solutions, the author has calculated the molecular moments of the derivatives with permanent dipoles. The values are as follows :—

$$CHCl = CHCl\ 1{\cdot}89 \times 10^{-18},\quad CHCl = CHBr\ 1{\cdot}55 \times 10^{-18}$$
$$CHBr = CHBr\ 1{\cdot}35 \times 10^{-18},\quad CHI = CHI\ 0{\cdot}71 \times 10^{-18}$$

A. B. W.

686. *Parachore and Chemical Constitution.* **S. Sugden** and **H. Wilkins.** (Chem. Soc., J. 127. pp. 2517–2522, Nov., 1925.)—Continuation of previous work [see Abstracts 41 and 42 (1926)]. Orientation isomerism studied in di-substituted benzene derivatives. Within limits of experimental error there is no appreciable difference between the parachors of ortho-, meta- and para-isomerides. Turner and Merry's data, giving a lower value for *m*-toluonitrile (Chem. Soc., J. 97. p. 2075, 1910), not confirmed.

A. D.

687. *Magnetism and the Structure of the Atom and the Molecule.* **B. Cabrera.** (J. de Physique et le Radium, 6. pp. 241–258, Aug., and pp. 273–286, Sept., 1925.)—A discussion on the present state of knowledge of

atomic structure. By means of a theorem of Larmor's, without any additional hypothesis as to structure, it is possible to calculate the mean radius of the electronic orbits. Taking Bohr's atomic scheme, the mean radius of the atomic surface is determined, employing the susceptibilities found by Hector and Pascal. The results agree with those found by Fajans and others. The magnetons of Weiss and Bohr are discussed, and the author considers that the following propositions are established : Bohr's magneton is the natural unit of magnetic moment of a free electronic orbit. Weiss's magneton is the greatest common measure of the magnetic moment of each system of electronic orbits, and it becomes the natural unit of magnetic moment for kations and paramagnetic atoms. A relation exists between the two magnetons, which is expressed approximately by $\mu_B = 5\,\mu_W$. Free atoms are orientated in an applied magnetic field according to the law of quantisation of space. From a knowledge of the variation of paramagnetism with the atomic number, the last electron attached to an atom may be located. The electronic arrangement found by this means agrees, for the iron group and that of the rare earths, with the scheme proposed by Stoner. The author, finally, discusses the constant Δ of the Curie-Weiss equation, the physical interpretation of which still remains obscure. Its value appears to depend on the action exerted on the paramagnetic atom by neighbouring atoms. G. E. A.

688. *Metastable $2p_3$ State of Mercury Atoms.* **S. Loria.** (Nat. Acad. Sci., Proc. 11. pp. 673–679, Nov., 1925.)—When a mixture of mercury vapour, thallium-vapour and nitrogen is exposed to $\lambda 2537$, a certain number of the activated atoms on collision with the nitrogen (or argon) will be converted into the metastable $2p_3$ state. In this condition it can only revert to the original state by collision with a thallium atom or a mercury atom, and, if the concentration of the mercury is kept low, the second possibility can be neglected. Hence it is suggested to estimate the time t_m in the metastable state by the increased intensity of a fluorescence line of thallium with nitrogen present. A simple theory is discussed and measurements of spectrum plates made with a registering microphotometer, and values for t_m are derived. It is pointed out that t_m is not an invariable quantity, but depends on the frequency of active collisions and hence on the concentration of thallium atoms. This is borne out by the experiments, the values being smaller as the temperature, and hence the saturation pressure, of thallium rises. The order of t_m is 10^{-4} sec. A. Wh.

689. *Brownian Motion and Stokes' Law.* **J. Weyssenhoff.** (Acad. Polanaise Sci. et Lettres, Bull. No. 7a. pp. 219–245, July, 1925. In English.)—Considerations of the molecular structure of the fluid in which a sphere (particle) moves introduces new complications connected with the Brownian movement, but does not exclude cases in which Stokes' law gives the mean velocity of the particle in the direction of the force. [See Abstract 1235 (1920).] If the mean free path of the fluid molecules becomes equal or even larger than the particle dimensions, the mobility is no longer given by Stokes' formula. The present paper first considers, in § 2, free Brownian movement exempt from the action of external forces, the motion of the particle being investigated as two motions, *viz.* : (1) irregular displacements to which the Brownian laws are applied ; and (2) the uniform translation of the mean position in the direction of the ex-

ternal force termed " wandering velocity." § 3 deals with the postulate of independence and laws of Brownian motion and examines a direct method of deducing these laws based on the principles of the dynamical theory of gases. § 4 investigates Brownian motion and theorems on distribution functions for sums of chance variables. § 5 deals with the identity of the phenomena of diffusion and Brownian motion, § 6 with the principle of superposition, and § 7 with Stokes' law. It is inferred that Stokes' law applies to the smallest perceptible particles in fluids, and that no serious errors result even from its application to amicrons and large molecules. In gases the deviations from Stokes' law occur already for ultramicrons under usual pressures and for arbitrarily large spheres under diminished pressures. In § 8 the applicability of Stokes' law to the wandering velocity of spherical particles in fluids is proved to the same degree of accuracy as that which obtains in deriving the hydrodynamical equations from the dynamical theory of gases. An appendix contains a review of known theorems on distribution functions for sums of chance variables.

H. H. Ho.

690. *Electro-physics.* **A. O. Rankine.** (Inst. El. Eng., J. 64. pp. 150–154, Jan., 1926.)

691. *Use of Grating and the Ether Drift Experiment.* **U. Doi.** (Inst. Phys. and Chem. Research, Tôkyô, Sci. Papers, No. 40. pp. 233–241, Aug., 1925.)—De Sitta in 1913 published two notes [Abstract 1418 (1913)] on the spectroscopic binary, showing therein to what degree the velocity of light *in vacuo* is unaffected by the velocity of its source. This, the author argues, has been regarded as if the result of binary observations afforded evidence for the validity of Einstein's postulate of the constancy of the velocity of light. The process of working is to select a region, say in the arc spectrum of Fe, where the lines are fairly defined, say about $\lambda 4860$, and to make a double exposure of a single photographic plate, one at noon and another at the following midnight, the whole system of slit, grating, and camera being shielded from any mechanical shock or disturbance. Two such exposures are made, and if the ether drift be of appreciable amount, a double line in place of a single one will be seen. Kayser's criticism on the use of gratings [Abstract 1348 (1904)] is referred to, and it is pointed out that discrimination is necessary to determine what part of any observed discrepancy may be due to imperfection in the gratings and not to the existence of an ether drift. G. W. DE T.

692. *Radiation Theory of Interatomic Repulsion.* **O. Lodge.** (Nature, 116. pp. 869–871, Dec. 12, 1925. Lecture delivered to the British Science Guild, Goldsmiths' Hall, Nov., 1925.)—The suggestion is made that the approach of two atoms under the influence of an impressed force causes perturbations to be set up in the motions of the constituent electrons with resultant emission of radiation. The resistance to approach which constitutes push or contact force becomes then another manifestation of radiation pressure. A. Wh.

693. *The Tensions of Radiation and their Interpretation in Terms of Classical Mechanics and Relativity.* **L. Brillouin.** (J. de Physique et le Radium, 6. pp. 337–353, Nov., 1925.)—A paper on similar lines to the next Abstract.

694. *On the Tensions of Radiation.* **L. Brillouin.** (Ann. de Physique, 4. pp. 528–586, Nov.–Dec., 1925.)—The forces exerted by a wave upon a partition (absorbing or reflecting) are usually termed radiation pressures, but the author prefers to employ the term tension because the force depends on the orientation of the partition and is not in general normal to it. These tensions have been evaluated by numerous investigators *via* indirect reasoning—for example, on the assumption that the wave conveys a certain quantity of motion. Their direct calculation described in this paper does not confirm such procedure, and another standpoint has therefore been adopted based on the total force and the flux of the quantity of motion, magnitudes which form a tensorial density. The average value of the components of this tensorial density give the tensions exerted by the wave upon a fixed absorbing wall. The calculations are first made for the case of waves of compression passing through a liquid, where the speed v depends on the density ρ. Next the elastic waves in a solid are considered, and for this purpose the forces have to be developed to the second order with respect to the deformations. Longitudinal and transversal wave tensions are derived, from which it is found that a wave reflected by a mirror and vibrating in the plane of incidence exerts a pressure normal to the mirror and independent of the incidence. The terms of the third degree are found to play an essential part in the calculation of the radiation pressures, and it is shown that these terms do not modify the speed of wave propagation for very small amplitudes, but that they cause a progressive deformation of the wave with the appearance of upper harmonics. The results obtained relating to radiation tensions in an elastic solid are not in accord with prevous data. The latter are now shown to be inexact, and are corrected in the paper. For this purpose a study is given of unilateral and isotropic dilatations, the wave velocities in the deformed solid being given completely for both cases. It is shown further that internal thermal effects in solids are resolvable into elastic waves exercising radiation pressures on the walls of the solid. It is also found that the older radiation pressure formulæ are inexact when applied to a unique wave, although the average values for completely diffused waves are correct. A formula for the radiation pressure is derived which differs but little from the equation of state of the solid as established by Debye and Ratnowsky by an indirect method. The paper is entirely mathematical. H. H. Ho.

ASTRO-PHYSICS.

695. *Solar Motion derived from Radial and from Transverse Velocities of Stars of Spectral Types F to M.* **W. M. H. Greaves.** (Roy. Astron. Soc., M.N. 86. pp. 40–43, Nov., 1925.)—Between Boss's determination of the apex from proper motions and Campbell's from radial velocities there is about 10° difference in declination for which Kapteyn proposes a systematic correction of $0''{\cdot}014 \cos \delta$. To test the origin of this large correction, the author determines the apex from the radial and transverse velocities of *the same selection of stars*, choosing Boss stars found in the Mt. Wilson Catalogue of 1646 spectroscopic parallaxes and 916 radial velocities derived from various catalogues. Each star yields the equations of condition: (1) $+ X \sin \alpha + Y \cos \alpha = V_\alpha \times 4{\cdot}74$; (2) $- X \cos \alpha \sin \delta - Y \sin \alpha \sin \delta + Z \cos \delta = V_\delta \times 4{\cdot}74$; (3) $+ X \cos \alpha \cos \delta + Y \sin \alpha \cos \delta + Z \sin \delta + K = V_r$. From these he derives four solu-

tions: I from (1), $V_\alpha s$ only; II from (2), $V_\delta s$ only; III from (1) and (2), $V_\alpha s$ and $V_\delta s$; and IV from (3), $V_\gamma s$. Solutions III and IV show a discrepancy in values of Z of about 10° in declination, which, if attributed to a systematic error, would give a correction of $+ 0''\cdot022 \cos\delta$ per annum to the proper motions in δ. The whole systematic error, however, cannot be deduced from the $\mu\delta_s$, but only one Fourier component of it. There is also a discordance of $4\cdot8 \pm 2\cdot5$ km./sec. in X between solutions I and II, which suggests a systematic error in the $V_\delta s$ depending on right ascension. A. S. D. M.

696. *Solar Radiation during the Total Eclipse of January 24, 1925.* **H. E. Seemann.** (Frank. Inst., J. 200. pp. 629–633, Nov., 1925.)—A Féry radiation pyrometer was adapted for use in relative radiation measurements during this eclipse, and the ratio of the energy received during full sunlight to the energy received from the corona was found to be 13,000. M. A. E.

697. *Radiation Measurements of the Solar Corona.* **E. Pettit** and **S. B. Nicholson.** (Mt. Wilson Observat. Contrib. No. 299. Astrophys. J. 62. pp. 202–225, Oct., 1925.)—Measurements were made during the eclipse of Jan. 24, 1925, with a thermocouple *in vacuo* placed at the focus of a 50·5-cm. mirror of 101-cm. focal length. The mean intensity of the coronal radiation at points $4'\cdot6$ from the east and west limbs of the moon was $5\cdot40 \times 10^{-7}$ of the integrated solar radiation. By means of a water-cell and thin glass plate it was found that the corona radiates slightly more energy on the violet side of $1\cdot3\ \mu$ than the sun does, and that the radiation of wave-length greater than $5\cdot5\ \mu$ is inappreciable. The corona was also photographed on plates provided with standard photometric squares, in order to investigate the distribution and total amount of the radiation; and it was found that the total light is $11\cdot2 \times 10^{-7}$ that received from the whole sun, or 0·52 that received from the full moon at mean distance. There is some evidence that it varies with the solar constant. The inner corona is redder than the outer, which implies that the light arises from luminescence or from molecular scattering in a gaseous atmosphere, not by reflection from solid or liquid particles. It is unlikely that the corona can be detected out of eclipse by radiometric methods, unless the scattered light near the sun can be reduced to one-hundredth of that observed on Mt. Wilson. M. A. E.

698. *Law of Sunspot Polarity.* **G. E. Hale** and **S. B. Nicholson.** (Mt. Wilson Observat. Contrib. No. 300. Astrophys. J. 62. pp. 270–300, Nov., 1925.)—The magnetic polarities of about 2200 sunspots observed at Mt. Wilson between 1908 and 1925 are discussed and classified. A new law of sunspot polarity is then advanced. Sunspots of a new $11\frac{1}{2}$-year cycle which appear in high latitudes after a minimum of solar activity are of opposite magnetic polarity in the two hemispheres. As the cycle progresses, the mean latitude of the spots decreases. The high-latitude spots of the next cycle, which overlap more than a year the spots of the preceding one, are of the reverse polarity. The true cycle for the recurrence of high-latitude spots of one definite polarity is really 23 years. This is termed the "magnetic sunspot period" in contradistinction to the $11\frac{1}{2}$-year frequency period.

Erratum (*ibid.*, 63. p. 72, Jan., 1926). A. Wh.

699. *Oscillation of the Solar Diameter.* **G. Armellini.** (Accad. Lincei, Atti, 2. pp. 293–299, Nov., 1925.)—Observations at the Royal Campidoglio Observatory in 1924 showed the mean diameter of the sun at mean distance, including irradiation, to be less than in 1923. This appears to bear out the hypothesis of Hilfiker and Lane that the sun is a pulsating star. [See Abstract 2456 (1924).] E. F.

700. *Cause of the Hydrogen Vortices round Sunspots.* **G. E. Hale.** (Nat. Acad. Sci., Proc. 11. pp. 691–696, Nov., 1925.)—Two explanations of the vortices round sunspots have been put forward. According to one they are truly hydrodynamical and to the other are electromagnetic in character. According to the electromagnetic theory, the vortex structure is simulated by the distribution of the projections of the lines of force. If this be so, the apparent direction of vorticity should be linked up with the polarity of the spot. Inspection of all the Mt. Wilson spectroheliograms which are free from complicating circumstances decides against this theory, there being no apparent correlation between polarity and direction of whirl. On the other hand, there is a strong tendency for the direction of whirl to agree with that of terrestial cyclones according to the hemisphere. A. Wh.

701. *On the Structure and Origin of Solar Magnetic Fields.* **S. Rosseland.** (Mt. Wilson Observat. Contrib. No. 302. Astrophys. J. 62. pp. 387–408, Dec., 1925.)—Discussion of Solar Magnetism on the Basis of Ordinary Electrodynamics and Electron Theory.—The first section of the investigation discusses the observations of the general magnetic field. It is pointed out that the current picture of the general magnetic field as being similar to that of an elementary magnet in each level, while the field-strength varies rapidly from level to level, is irreconcilable with ordinary magnetic theory. An alternative, not suffering from this disadvantage, is discussed. The second section considers the origin of the magnetic fields. It is shown that the motion of an ionised gas must, in general, be accompanied by an electric current, even if, macroscopically, the gas is electrically neutral. This effect, as well as others, appears to be much too small to account for the large values of the field found by observation. If the solar substance emits long-range β- or α-particles, the situation would be more favourable for an explanation, although we should have to contemplate very extreme conditions in order to explain solar magnetism in this way. AUTHOR.

702. *Recent Investigations on the Auroral Spectrum.* **H. J. C. Ireton.** (Roy. Astron. Soc. Canada, J. 19. pp. 289–292, Dec., 1925.)—The author reviews very briefly what has been discovered concerning the aurora since 1716. It is now generally believed to be due to action upon our upper atmosphere of highly penetrating kathode-rays from the sun, which have recently been measured by Millikan. In 1925 McLennan and Shrum succeeded in producing all the well-known lines of the auroral spectrum, including the prominent green line at 5577·350 I.Å., by the excitation of small quantities of air in large mixtures of helium. M. A. E.

703. *Equilibrium of Calcium Chromosphere.* **E. A. Milne.** (Roy. Astron. Soc., M.N. 86. pp. 8–28, Nov., 1925.)—In a previous paper [Abstract 1034 (1925)] a theory was given of the equilibrium of Ca^+ atoms

in the chromosphere with the assumption that there were only two stationary states of equal weight. In this paper account is taken of the unequal weights of the 1σ and the 1π levels, of the duplicity of the 1π level and of the metastable 1δ levels. The new theory leads to a value of $\tau = 1{\cdot}8 \times 10^{-8}$ sec. as against $0{\cdot}6 \times 10^{-8}$ sec. The infra-red Fraunhofer and flash spectrum lines $\lambda\lambda$8498, 8542, 8662 are due to the 1δ states of the Ca^+ atom, and these will be expected wherever the H, K lines are emitted. The previous formula for the residual intensity in the H and K lines is corrected by division by the factor $(1 + \nu' t/\nu t')$, where ν' is the mean frequency of the infra-red lines and t' the average life of the 1π state with reference to transitions to the 1δ state. A. Wh.

704. *Penetrating Radiation and Cosmical Physics.* **J. H. Jeans.** (Nature, 116. p. 861, Dec. 12, 1925.)—If annihilation of pairs of protons and electrons is continually giving rise to radiation, it is shown that the wave-length will be $1{\cdot}3 \times 10^{-13}$ cm., and that the photoelectrons emitted by its subsequent absorption will have a velocity of 0·99999985 the velocity of light. Successive absorbtion and photoelectric emission will cause degeneration into ordinary heat vibrations, and it is unlikely that much high-frequency radiation will be able to escape from the interior of a star. From nebulæ it will have fairly free emission, and it is estimated that the penetrating radiation from the Andromeda nebula will alone account for half the observed atmospheric ionisation, the actual energy falling on the earth being 10^{-4} ergs/sec./cm.^{2} [misprint 15^4 in paper]. It seems doubtful whether the wave-length of the radiation observed by Millikan is nearer 4×10^{-12} or $1{\cdot}3 \times 10^{-13}$ cms. If the greater wave-length can be substantiated, the hypothesis put forward by Millikan is nearer the truth than that advanced in this paper. Bombardment by very high-speed electrons with their associated radiations is a factor to be taken into account in many cosmical processes. For instance, the luminosity of the irregular nebulæ and the negative charge of the earth can be explained by their action. A. Wh.

705. *Perihelion Motion of a Variable Mass.* **G. v. Gleich.** (Ann. d. Physik, 78. 5. pp. 498–504, Dec., 1925.)—The position of the orbital ellipse in space has been determined for constant mass in the problem of two bodies, and the motion of the elliptic axes is now investigated on the following assumptions: (1) The attractive force is the Newtonian $f \cdot Mm/\Delta^2$, wherein f is the attraction constant, M the sun's mass, m that of the planet (both treated as spherical), and Δ the distance between the middle points. If R and r be the distances of M and m from the common centre of gravity, then $\Delta = r(1 + m/M)$, and in the case of Mercury m/M is about $1{\cdot}5 \times 10^{-7}$. (2) The force is defined as the differential quotient of the motion mv by the time t. The velocity v of the planet is referred to a rotation-free (inertial) system connected with the centre of gravity of the system. There follows as a fundamental formula $d(mv)/dt = -f \cdot mM/r^2(1 + m/M)^2$. (3) The energy E has a mass E/c^2 (c = velocity of light), from which it follows that $m = m_0(1 - \xi)^{-\frac{1}{2}}$, where $\zeta = v^2/c^2$ and is of the order $2{\cdot}6 \times 10^{-8}$. Finally, all vector quantities used obey the parallelogram law. The paper is entirely mathematical. H. H. Ho.

LIGHT.

706. *Mechanically-induced Double Refraction of Amorphous Fluids and Molecular Shape.* **D. Vorländer** and **R. Walter.** (Zeits. phys. Chem. 118. pp. 1–30, Oct. 25, 1925.)—Homogeneous oils differ from mixtures and solutions. When we compare specific double refractions $[D] = D/uz$ (where D is the observed double refraction, u is the number of revolutions in the apparatus, and z is the viscosity of the fluid), it is found that [D] is greater the more linear the molecular shape or construction in amorphous oils, and that in these the double refraction is normal. In colloidal resins and solutions there are no such definite relations; anomalous double refraction has been found in several instances; it appears that the double refraction is due to groups of molecules. A. D.

707. *Irregular Astigmatism of the Eye: Effect of Correcting Lenses.* **H. H. Emsley.** (Optical Soc., Trans. 27. 1. pp. 28–41; Disc., 41–42, 1925–1926).—Experiments to test the grating acuity of the eye in different meridians reveal the prevalence of irregular refraction, or astigmatism as it is usually called. Comparisons are made between the ordinary subjective findings and tests made on gratings. The effects of changes of lens power on the acuity in different meridians of the eye are considered. A redistribution of the acuity over the several meridians during accommodation is indicated. AUTHOR.

708. *Fading of Coloured Materials by Daylight and Artificial Light.* **M. Luckiesh** and **A. H. Taylor.** (Am. Illum. Eng. Soc., Trans. 20. pp. 1078–1095; Disc., 1095–1099, Dec., 1925.)—Coloured silk ribbons were tested under sunlight, daylight, gas-filled lamps, and white-flame arc lamps. The effects of various factors, such as illumination intensity, spectral character of the radiation, temperature, humidity, etc., were studied. It was found that similar exposures in foot-candle-hours with similar kinds of light produce about equal fading. Light tints of blue and red fade most rapidly. The wave-length in the visible spectrum made little difference, except that some few dyes were specially sensitive to yellow—yellow-green light 577 $\mu\mu$–557 $\mu\mu$. Temperature alone had no effect on the rate of fading, but heat helped light to fade the specimens. Moisture in the air made little difference to fading, but altered the texture very much. Very little fading of ribbons could be produced when in a vacuum. The average results of tests on 23 ribbons show that exposure to sunlight and skylight at 3900 foot-candles for eleven hours, or to skylight alone at 450 foot-candles for forty hours, will cause as much fading as exposure to 500 foot-candles from tungsten lamps for 100 hours. Also, that approximately equal degrees of fading will result from exposures to tungsten filament radiation amounting to 100-foot-candle-hours, skylight 34-foot-candle-hours, or to sunlight and skylight combined 77-foot-candle-hours. Most of the ribbons had lost some of their strength where faded. Tables and diagrams of results for various colours are shown, together with spectrograms of the lights used.

W. C. S. P.

709. *Diffuse Radiation from Dielectric Spheres.* **G. Jobst.** (Ann. d. Physik, 78. 2. pp. 157–166, Nov., 1925.)—A discussion of three cases in which parallel incident light is deviated from its course; Rayleigh's radiation (small spheres) when the indices of refraction of the spheres and the external medium are nearly equal, large spheres in the like case, and shadow-production. Formulæ developed, and three laws of radiation found. A. D.

710. *Lagrange's Theorem and Stationary Functions.* **T. Smith.** (Optical Soc., Trans. 27. 1. pp. 43–50, 1925–1926.)—The evaluation of functions when they are stationary for small changes in the values of their variables is of great importance in the development of a theory of optical instruments on the basis of wave propagation. The discussion of this problem leads naturally to expansion by means of Lagrange's theorem, and the extended form of this theorem for several variables is now expressed in a concise notation. It is then used to evaluate a function of the above type. H. H. Ho.

711. *Lens Polariscopes.* **H. Schulz.** (Zeits. techn. Physik, 6. 11. pp. 614–618, 1925. Zeits. Instrumentenk. 45. p. 539, Nov., 1925.)—The first paper includes the theory of lens polariscopes. By the use of suitable combinations of a calc-spar and a glass lens the relation of focal length for the ordinary and extraordinary rays can be adjusted to almost any value, and a system available for many different purposes can be obtained. Chromatic correction of both rays can be obtained by the addition of a simple system, or by change of the distance apart of the components of the original system. The chief advantage over ordinary polarisers is in the greater intensity obtained. The second paper gives a little more detail concerning the simple polariser formed of a plano-concave and a plano-convex lens of calcspar, each having the same curvature, but one having the crystal axis parallel and the other perpendicular to that of the lens. W. H. Ge.

712. *Aspherical Lens Systems.* **L. Silberstein.** (Eastman Kodak Co. Research Lab., Comm. No. 243. Optical Soc. America, J. and Rev. Sci. Inst. 11. pp. 479–494, Nov., 1925.)—A mathematical paper giving a general method for building up an aberrationless system of any number of refracting Cartesian surfaces, each of these introducing a new free parameter. It is shown how such parameters can be utilised for satisfying other requirements in addition to that of the freedom from aberration. As an example a method is worked out for fulfilling, by means of two Cartesian surfaces, the sine-condition up to the fourth-order terms, and thus constructing an aplanatic lens. Lastly, the achromatisation of such a lens by the insertion of a third surface is dealt with in a general way, and is illustrated by a numerical example. W. H. Ge.

713. *Self-registering Spectrothermograph.* **J. W. Ellis.** (Optical Soc. America, J. and Rev. Sci. Inst. 11. pp. 647–652, Dec., 1925.)—Describes a refined form of instrument in which infra-red spectra falling upon a thermopile cause movements of a galvanometer mirror, which throws a spot of light on to a photographic plate. The transverse motion of the plate is coordinated with the rotation of the prisms by shafting. The technique is described, and curves published illustrating what can be done with the instrument. A. C. M.

714. *Some Recent Improvements in Modern Ophthalmic Lenses.* **S. A. Emerson.** (Optical Soc., Trans. 27. 1. pp. 1–6; Disc., 7–8, 1925–1926.) —A short account of the ordinary forms of invisible fused bifocals is given together with some of the limitations inherent in them. The reason for the unavoidable increase of the chromatic aberration in the positive combinations is shown to lie in the use of ordinary dense flint to produce the reading addition. The optical and physical properties necessary in two glasses which shall fuse together to form a bifocal with a minimum of colour are stated, and new bifocals made of glasses with the required properties are described. Possible modifications in the shape of the reading portion are shown, giving greater control of the prism introduced and permitting distinct distant vision through the bottom of the lenses. A brief description of some improved forms of medium power and cataract lenses is included. AUTHOR.

715. *Measurements with a Lummer-Gehrcke Plate.* **J. K. Robertson.** (Optical Soc. America, J. and Rev. Sci. Inst. 11. pp. 559–653, Nov., 1925.) —The author points out that this apparatus quite easily lends itself to experiments suitable for senior students, and describes the arrangement in use in his laboratory. Among the measurements that may be made are the thickness, the order of interference, calculation of the index, etc. The original paper should be consulted by those interested in the teaching of advanced practical optics. [See Abstract 343 (1925).] F. S. B.

716. *Measurement of the Ultra-violet Dispersion of Carbon-disulphide.* **G. Bruhat** and **M. Pauthenier.** (J. de Physique et le Radium, 6. pp. 287–294, Sept., 1925.)—The dispersion measurements described are made with special reference to the absorption band in the neighbourhood of 320 $m\mu$. The method of crossed prisms—two quartz prisms right and left, and a CS_2 prism of small angle—is employed, in conjunction with a mercury arc, and also with a Cu-Zn spark. A diminution of separative power within the absorption band is discussed, and an anomaly in the relation between absorption and dispersion, of the order of the maximum of the index of extinction, is noted. A. B. C. L.

717. *Aberration Diffraction Effects.* **G. C. Steward.** (Roy. Soc., Phil. Trans. 225. pp. 131–198, Nov. 5, 1925.)—The image of a luminous point, given by a symmetrical optical system, will not itself be a point; the whole wave is not taken in, and the emergent wave will in addition be distorted by the geometrical aberrations (spherical aberration, coma, astigmatism, curvature of the field, distortion). The present paper considers, mathematically, the modification of the "ideal" diffraction pattern produced by these geometrical aberrations. The method followed depends upon the Eikonal Function of Bruns, of which an account is given. The forms of aperture considered are (1) the usual circular aperture with the central portion stopped out (Rayleigh); (2) one (or two parallel) narrow rectangular apertures (diameter of large stars, separation of double stars); (3) semi-circular (as in heliometer). A certain general function arises in the course of the investigation, and a detailed examination of this is given in an appendix. A. D.

718. *Generalisations of the Rayleigh Formula for Molecular Scattering.* **J. Q. Stewart.** (Optical Soc. America, J. and Rev. Sci. Inst. 11. pp. 581–

597, Dec., 1925.)—A Unified Treatment of the Rayleigh, Einstein-Smoluchowski, and Cabannes-King Formulæ.—Schuster has shown that the well-known Rayleigh formula for molecular scattering of light can be derived from the general wave theory without special postulates (usually introduced) which are peculiar to the elastic-solid, the electromagnetic, or the electron theory. The present report—the contents of which are theoretical and mathematical—discusses the restrictions of the Rayleigh formula, and extends Schuster's demonstration to the two generalisations which have been developed, respectively, by Smoluchowski and Einstein, and by Cabannes and King. The former applies to dense media, and the latter to scattering by anisotropic molecules.

Extensions of the Rayleigh Formula.—The same method leads to two new generalisations. The first theoretically applies to resonance scattering, and, in a special case, is equivalent to a formula derived by Lamb. The second applies to scattering by a gas which contains active molecules of more than one type.

The relation of scattering to opacity is briefly discussed. A partial bibliography of Rayleigh scattering and of opacity in general is included. The standpoint throughout is that of classical theory ; the quantum theory of scattering is not dealt with in this report. AUTHOR.

719. *Colour Measurement with Pulfrich's Photometric Comparator.* **C. Pulfrich.** (Zeits. Instrumentenk. 45. pp. 521–530, Nov., 1925.)—Describes an arrangement of colour-specimens for use with the step-by-step photometer [see Abstract 1626 (1925)] for the description of a colour on the Ostwald system. The specimen is compared with the samples of the standard colour series, and its purity (mixture with white) and brightness (mixture with black), or that of the similarly coloured standard sample is altered until equality is obtained. The different cases which may arise in practice are discussed. J. W. T. W.

720. *Spectral Centroid Relations for Artificial Daylight Filters.* **K. S. Gibson.** (Optical Soc. America, J. and Rev. Sci. Inst. 11. pp. 473–478, Nov., 1925.)—If K_λ, E_λ and T_λ be respectively the visibility factor, energy per unit wave-length of the incident light, and transmission factor, all at wave-length λ, then the function $\Sigma K_\lambda E_\lambda T_\lambda \,.\, \lambda / \Sigma K_\lambda E_\lambda T_\lambda$ may be termed the spectral centroid, or wave-length centre of gravity, λ_c of the luminosity curve of the transmitted light. The author gives the results of measurements on a number of "daylight" glasses, and shows that for a given light source a linear relation exists between the thickness of the glass and the spectral centroid of the transmitted light. Further, for a given filter a linear relation exists between the spectral centroids of light at various colour temperatures and of the same light transmitted by the filter.

J. W. T. W.

721. *Visible Decomposition of Silver Halide Grains by Light.* **A. P. H. Trivelli** and **S. E. Sheppard.** (Eastman Kodak Co., Research Lab. Comm. No. 235. J. Phys. Chem. 29. pp. 1568–1582, Dec., 1925.)—Microscopic observation of the photochemical darkening of specially prepared AgBr crystals shows that decomposition occurs in definitely oriented patterns, of which illustrations are given, depending upon the growth and structure of the crystal. Statistical study made of the visible darkening of AgBr grains in emulsions reveals a decomposition largely

irregular in character. The visible sensitivity is found to increase with the size of grain in the same emulsion. The lack of parallelism between the developable sensitivity and the visible sensitivity of different emulsions is due to the fact that the visible sensitivity is relativity independent of sensitivity nuclei. It is suggested that the photochemical decomposition is oriented in the crystal according to the gradients of ionic deformation or perturbation of electron orbits following certain directions of growth. Since sensitivity nuclei, as also the reduced Ag, will induce marked deformation of contiguous AgBr, the decomposition becomes autocatalytically oriented, which explains the contrast in behaviour between the specially prepared AgBr crystals and emulsion grains, as well as the observed effect of the size of grain. A. B. C. L.

722. *Relation between Time and Intensity in Photographic Exposure.* **L. A. Jones** and **E. Huse.** (Optical Soc. America, J. and Rev. Sci. Inst. 11. pp. 319–340, Oct., 1925.)—The authors have recently published [see Abstract 1444 (1924)] results of investigations of the so-called reciprocity law on three well-known photographic materials. The data published at that time were the results of an extensive series of measurements, and afforded reliable information on the relation between the time and intensity factors of exposure. The materials used were Seed 23 plates, Seed 30 plates, and Motion Picture Positive Film. From the results with these materials some very definite conclusions were drawn. It was found that (*a*) there was a definite failure of the reciprocity law; (*b*) the Schwarzschild equation, $E = I \cdot t^p$, would not fit the observed values; and (*c*) the experimental determination of the value of "optimal" intensity was subject to great uncertainty due to the flatness of a large portion of the D-log I curves. Furthermore, it was found in the case of one of the materials studied that gamma (γ) was to a certain extent dependent upon intensity, while in the case of the other two materials γ was independent of intensity. A further study of the failure of the reciprocity law has now shown considerable advance towards its solution, and has quite definitely established the fact that there is a definite failure of the reciprocity law. An empirical expression, similar in form to that applied by Kron to his "curve of constant density," is found to fit very well the density-log I curves of constant exposure for some of the photographic materials studied. In the case of one of the materials investigated this formula could not be applied with the same certainty as with the others, since, in making the exposures sufficiently high, values of intensity to make possible the definite determination of log I_0 were not used. The evidence seems to be very conclusive that in the case of some materials a fixed development time gives curves of which the γ value is dependent upon the absolute value of intensity. In these cases the γ becomes less for the lower intensities, but a corresponding decrease of gamma at the high-intensity end of the scale is not observed. It is hoped that when complete data are available on a greater variety of photographic materials it will be possible to construct an expression which will be of more general application than those thus far proposed. Further work is in progress.
A. E. G.

723. *Fluorescence of Cadmium Vapour.* **A. D. Power.** (Phys. Rev. 26. pp. 761–764, Dec., 1925.)—Cadmium vapour, in an evacuated and carefully baked quartz tube, when illuminated by cadmium, iron and nickel

sparks, was found to emit the lines 3262 Å. ($1S - 2p_2$), 4678 Å. ($2p_3 - 1s$), 4800 Å. ($2p_2 - 1s$) and 5086 Å. ($2p_1 - 1s$) much more strongly from freshly formed vapour than from older vapour. The line 2289 Å. (1S – 2P) also appeared slightly stronger in the freshly formed vapour when illuminated by the cadmium spark; it was not excited by iron and nickel sparks. Experiments are described which indicate that it was the freshness of the vapour, not primarily the temperature or pressure, which determined the intensity of the radiation. The effective exciting light was absorbed by glass, hence shorter than 3300 Å. A Cu spark did not excite the lines, at least in the visible.

Impurities in the cadmium vapour gave strong fluorescent Th and In lines ($2p_2 - 2s$) and ($2p_1 - 2s$), although spark-spectra using the cadmium metal as electrodes did not reveal their presence. These lines were radiated only by the freshly formed vapour, and appear to be the result of directly absorbed radiant energy rather than of collisions of the second kind. They were weaker with Cd spark excitation than when light from a Ni or Fe spark was used. Light from a Cu spark excited only the Th lines. AUTHOR.

724. *Depolarising Influence of Alternating Magnetic Fields on Resonance Radiation.* **G. Breit.** (Optical Soc. America, J. and Rev. Sci. Inst. 11. pp. 465–471, Nov., 1925.)—A mathematical investigation on the classical isotropic oscillator in which the author compares his results with those obtained by Eldridge. The original paper should be consulted for further particulars. W. C. S. P.

725. *Application of the Vacuum Thermoelement to the Measurement of the Energy in the Spectrum.* **W. J. H. Moll** and **H. C. Burger.** (Rev. d'Optique, 4. pp. 562–567, Nov., 1925.)—The vacuum thermoelement described in Abstract 123 (1926) may be used for comparing the intensities of spectrum lines. The lines are thrown successively upon a slit, an image of the slit being projected upon a linear element by a microscope objective. The size of the slits employed is governed by the size of the element, and the sensitivity obtained with a given dispersion is only limited by the resistance of the element. The application of the method is illustrated by the results obtained from measurements of the spectrum of mercury. A. W. L.

726. *Intensities of Band Lines.* **E. C. Kemble.** (Zeits. f. Physik, 35. 4. pp. 286–292, 1925.)—In previous papers [Abstract 1368 (1925)] the author has developed a theory of the intensities of absorption of infra-red radiation by HCl, HBr, etc., the theory being based on the Correspondence Principle. The following formula is derived for the line absorption coefficient, $\alpha = \text{const.}\ \bar{p}/\nu^3\ .\ e^{-E''/KT}$, where E″ is the energy of the initial state and $\bar{p} = \frac{1}{2}(p' + p'')$ the mean *à priori* probability of the states involved. Corresponding formulæ for emission are derived, and certain values of the probabilities found to agree with experimental results.

A modified derivation of the intensity formula is obtained, using the formulæ for the intensities of Zeeman components for the "summation" rules. Then, making the assumption that the electric moment of the molecule may be connected with Fourier components of the type $Ce^{\pm 2\pi i(\omega_e + T\omega_n \pm \omega_r)}$ where ω_r is the frequency of nuclear rotation, and

$\omega_e + T\omega_n$ the combination frequency of electron frequency ω_e and vibration frequency ω_n, the previous intensity rules may be deduced. A criticism is made of the Fowler and Dieke theory developed by the direct use of the Burger-Dorgelo rules for band lines extended to rotation vibration spectra with two branches. Thus it is found according to this theory that the relative intensities of doublets are in the ratio 1, 3, 5 . . . whereas these energy relations are found not to hold for the rotation-vibration bands of HCl. The Fowler theory hence leads to a violation of the Bohr correspondence condition that in the region of larger quantum numbers the results of quantum transitions should agree with classical theory, and is hence to be mistrusted. W. V. M.

727. *Rules of Spectral Structure.* **O. Laporte** and **W. F. Meggers.** (Optical Soc. America, J. and Rev. Sci. Inst. 11. pp. 459–463, Nov., 1925.)—Three empirical rules are pointed out. The first has been given by Catalán, who divides the elements between A and Cu into two groups of five, there being similarity of position of the terms in the energy diagrams, and identity of azimuthal quantum number of the normal states for corresponding elements in these groups. The elements Ca to Cu can be similarly arranged with respect to the first spark spectrum. The second is that the *raies ultimes* of both arc and spark spectra are combinations of the lowest term with the first higher non-metastable term of the same series system. Thirdly, if a "resonance line" be defined as the transition requiring least energy, such a line is a combination of the lowest term with a term of highest multiplicity in the spectrum. F. S.

728. *Fulcher Lines.* **C. R. Bury.** (Phil. Mag. 50. pp. 1139–1143, Nov., 1925.)—A new form of arrangement of the Fulcher bands is suggested. Thirty lines are classified as the three brightest lines of ten different bands, instead of in two bands, as arranged by Fulcher. The bands are again divided into two branches. This leads to a further classification of a number of lines. A. C. M.

729. *Application of the Correspondence Principle to Relative Intensities in Series Spectra.* **F. C. Hoyt.** (Phys. Rev. 26. pp. 749–760, Dec., 1925.)—A brief discussion is given of the representation of intensities in emission and absorption in terms of the probabilities of transition and of the estimation of the probability $A'_{,,}$ of spontaneous transition in the usual way based on the correspondence principle. It is shown that on the basis of the Bohr theory approximate values of $A'_{,,}$ may be obtained in many cases from the information as to the parameters of the stationary orbits which is given by the values of the spectral terms and their quantum numbers, together with the harmonic analysis of the penetrating orbits given in a previous paper [Abstract 1326 (1925)]. In other cases a detailed knowledge of the intermediate orbits is shown to be necessary. Calculations are made of the relative probabilities of the transitions involved in the principal series of sodium. The values obtained by different methods of averaging are compared with the experimental results of Harrison [Abstract 2097 (1925)]. A possible explanation is offered of the observed relative intensities in emission of certain lines with the same initial state. It is pointed out that the frequencies of the spectral lines may be approximately calculated from the orbital

frequencies of the series electron when the orbits are similar as in the case of *sp* combinations. AUTHOR.

730. *Primed Terms in the Spectra of the Lighter Elements.* **O. Laporte.** (Washington Acad. Sci., J. 15. pp. 409–413, Nov. 4, 1925.)—It is pointed out in the first place that the terms of the arc spectra of Ca, Sc, Ti, etc., can be obtained from the low terms of their first spark spectra, assuming that the quantum number related to term character is not identical with the azimuthal quantum k of the last bound electron, but is the resultant of moments of momenta of all valence electrons. The PP′ doublet system found for SiII by Fowler, and for AlI, PIII, SIV, ClV, CII, NIII, OIV by Bowen and Millikan is considered, and a different explanation given from that put forward by the latter authors. It is concluded that the frequencies of such (^{2}PP′) series would be expected to follow the irregular doublet law, and the same is predicted for the (^{2}PD″) groups. (^{3}PP′) groups such as those of MgI, AlII, etc., are similarly discussed. F. S.

731. *Infra-red Absorption Spectrum of Molten Naphthalene.* **F. K. Bell.** (Am. Chem. Soc., J. 47. pp. 2811–2816, Nov., 1925.)—A heating cell is described which enables absorption spectra of solid compounds which melt at fairly low temperatures to be determined for the molten state. The absorption spectrum of molten naphthalene at 95° has been determined as far as $12{\cdot}0\,\mu$, and that of benzene for the same region. A comparison of these spectra reveals a pronounced similarity as far as $5{\cdot}5\,\mu$, but beyond this point an increasing dissimilarity as longer wave-lengths are approached. F. S.

732. *Infra-red Spectra of Solutions.* **O. Reinkober.** (Zeits. f. Physik, 35. 3. pp. 179–192, 1925.)—The spectrum was produced by the use of a Nernst lamp and a rock-salt prism, the radiation being detected with a low-resistance linear thermopile system. The liquid to be investigated was placed between two fluorspar plates, the galvanometer deflections with and without the screen being compared.

Reflecting powers were also investigated. Sharp reflection maxima were found for water at $3{\cdot}23$ and $6{\cdot}22\,\mu$ in agreement with previous investigators. A solution of MH_4Cl in water shows, in addition, a strong reflection at $7{\cdot}01\,\mu$ near to a position of maximum absorption for the solid substance. A flat maximum at $4{\cdot}7\,\mu$ visible for pure water appears to shift slightly to shorter wave-lengths. In the case of NH_4 halogen salts it is shown that the internal characteristic frequencies of the NH_4 ions move towards shorter wave-lengths during the transition from solid to solution. This is a shift in the opposite direction from that usually found. The influence of the solvent on the position of the $7\,\mu$ absorption line was investigated. The absorption spectra of water, ethyl alcohol, methyl alcohol, propyl alcohol and glycerin were investigated, the various alcohols showing absorption of the same type. A band at $3{\cdot}05\,\mu$ due to the hydroxyl group was present in all cases, while other bands at $6{\cdot}05$ and $4{\cdot}66\,\mu$ seem to correspond to characteristic frequencies of this OH group. The bands obtained for various solutions of NH_4Cl in these various solvents were also investigated, and the conclusion reached that the characteristic frequency of the ions in the different media remains the same. W. V. M.

733. *Change in the Infra-red Absorption Spectrum of Water with Temperature.* **J. R. Collins.** (Phys. Rev. 26. pp. 771–779, Dec., 1925.)—By the use of two constant deviation spectrometers in series and a Coblentz linear thermopile, the absorption coefficient of water was measured for various temperatures from 0° to 95° C. The bands found showed maximum absorption at the following wave-lengths :—

At 0° C. :	0·775	—	0·985	1·21	1·45	1·96 μ
At 95° C :	0·74	0·845	0·97	1·17	1·43	1·94 μ

There is a shift toward shorter wave-lengths as the temperature increases and also a marked increase in magnitude of the maximum absorption for the bands at 0·77, 0·98, and 1·21 μ. These changes are qualitatively explained by Röntgen's hypothesis that water is a mixture of at least two kinds of molecules, presumably $(H_2O)_2$ and $(H_2O)_3$, whose relative amounts change with a change of temperature. AUTHOR.

734. *The Infra-red Spectrum of the Calcium Arc in Vacuo.* **O. Sandvik** and **B. J. Spence.** (Astrophys. J. 62. pp. 265–269, Nov., 1925.)—The investigation was undertaken with the following three-fold object in view : (1) To study the arc *in vacuo* as a source of radiation for radiometric investigation of its spectrum ; (2) to study possible differences between the spectrum of the arc *in vacuo* and at atmospheric pressure ; (3) to obtain wave-lengths of new lines if they were found to exist. A very steady source of radiation for radiometric observation was developed, some differences largely in intensity between the arc *in vacuo* and at atmospheric pressure were observed, and the wave-lengths of seventeen new calcium lines beyond the wave-length 1·0 μ were obtained. More lines were present, but their intensity was too small to obtain determinations of wave-length. AUTHORS.

735. *Spectra in the High-current Arc.* **A. S. King.** (Mt. Wilson Observat. Contrib. No. 298. Astrophys. J. 62. pp. 238–264, Nov., 1925.)—Spectra were photographed of Fe, Ti, Mg, Ca, Cu, and Al from an arc at 100 volts carrying 1000 amps. Certain lines of Na, Ga, O, and N are also described. The high-temperature lines are intensified ; there is much widening with asymmetry and often shifts. Reversals are numerous, especially in the short-wave region. A continuous spectrum appears in the ultra-violet. Selection of groups is facilitated by the widening. Low energy levels are coupled with symmetry, and *vice versa*. A. C. M.

736. *Emitters of Band-Spectra.* **R. S. Mulliken.** (Phys. Rev. 26. pp. 561–572, Nov., 1925.)—One-valence electron molecules are considered, and the bands emitted by them discussed in "series."

Series *A.*, *e.g.* BeF, BO, CO^+, CN, N_2^+.—They contain, like Na, nine electrons excluding the nuclear and K electrons. The CO^+ bands are discussed and analogies with the bands of BO and CN are pointed out ; also analogies between CN and N_2^+. The lines of the known band systems for these molecules can be expressed as combinations of three electronic terms ; a singlet N term belonging to the normal state, a doublet term A corresponding to the first excited state, and a singlet B term corresponding to the second excited state. It is probable that the average angular momentum of the emitting (ninth ?) electron is the same for the N and the B states. In the cases of BO and CO^+ all the three

possible combinations between N, A, and B are known; two for CN, and one for N_2^+; the unobserved systems are probably in the infra-red. The spectra of the above molecules show remarkable parallelisms.

Series *B.*, MgF, AlO, SiN.—These contain an additional electronic shell. They are the probable emitters of spectra showing analogies with those of BeF, BO, and CN.

Other Series, CaCl, SrBr, etc.—It is further suggested to group bands according to the number of valence electrons of the emitters; *e.g.* HF, LiF, BN, NaCl, etc., show analogy to the rare gases. CO, NO^+, N_2, SiO should resemble the alkaline earths.

Two causes of multiplicity in band-spectra are considered—interaction between the emitting electron and the rest of the molecule, and interaction of the angular momentum of the emitting and other electrons with that of the nuclei.

It is suggested that the second negative N_2 bands of Duffendack may be due to neutral N_2 molecules in each of which two electrons are initially excited. Also the familiar aluminium bands are probably due to AlO. A. C. M.

737. *Red Neon Lines.* **K. Burns.** (Optical Soc. America, J. and Rev. Sci. Inst. 11. pp. 301–310, Oct., 1925.)—The wave-lengths of these lines, as measured on 68 plates taken at Allegheny Observatory using etalons of four different thicknesses are compared with the values adopted by the Bureau of Standards, and also with the measurements of Meissner, Priest and Wallerath. It is concluded that the Bureau of Standards values are sufficiently accurate to justify taking the means to four places of decimals, and that no change in the relative values of these means is indicated. In the case of the 6217 line, the value 6217·2807 is considered preferable to the accepted value of 6217·280 Å. Further, the lines in question have no complexities which interfere with the accuracy of measurement with orders up to 100,000 if the source of the lines be similar to that used by the Bureau of Standards. F. S.

738. *Secondary Standards of Wave-length in the Spectra of Neon and Iron.* **G. S. Monk.** (Astrophys. J. 62. pp. 375–386, Dec., 1925.)—The primary standard.—The wave-lengths of the primary standard from a Michelson H-tube and from two other sources have been compared by means of the interference spectrograph, and the wave-length from one of these, a modified and brilliant tube, has been compared with the wave-lengths of several neon lines recommended by the Committee on Wave-Lengths of the International Astronomical Union.

Neon.—The values obtained for 20 neon lines by compiling the results of a large number of observations on neon indicate that the recommended values for 2 lines, 5852 Å. and 6402 Å., are questionable.

Wave-lengths from the standard iron arc.—In the spectrum of the recommended standard iron arc, 110 lines, including secondary standards between λ3445 Å. and 6678 Å. and certain suggested substitutes for unstable secondaries, have been compared with the spectrum of neon by the interference method. The observed values of the iron lines to the violet of 6000 Å. agree well with the last observations of Meggers, Kiess, and Burns, while to the red of 6000 Å. they are systematically about 0·002 Å. lower than those of the latter observers. Also, there are indications that the values of all the *b* lines are systematically lower in the Pfund arc.

The value of the probable error.—It is believed that the present ratings A, B, and C for the probable errors, as recommended by the International Astronomical Union, should be revised to a more rigorous scale. Further, since with a large number of observations it is possible to obtain a rating of A from values which are not sufficiently consistent to ensure accurate reproduction with one or two exposures, it is suggested that some indication should be made in tables of secondary standards of the consistency of the measures for different exposures for a given standard.

The iron arc *in vacuo*.—Observational work done thus far on the vacuum iron arc leads to the belief that the adopted system of standards in the spectrum of iron should be based on the arc at atmospheric pressure.

AUTHOR.

739. *Intensity Measurements in the Iron Spectrum. I.* **J. B. van Milaan.** (Zeits. f. Physik, 34. 11–12. pp. 921–923, 1925.)—The intensities were measured in a $\overline{f}_j - \overline{d}_j$ multiplet of 12 lines, 5506·785 → 5269·538. The intensities were compared with the proportional intensities deduced from the summation-rule [see Abstract 1455 (1924)] and the agreement was bad. Search was made for discrepancies, and these were tracked down to self-reversals on the plates; the current used was 4–5 amps. An exposure was then taken with an arc maintained at 0·45 amp., and the intensities observed were in excellent agreement with the summation-rule. It is clear that the intensity-ratio formulæ of Sommerfeld, Hönl, Kronig, and Russell are approximate only. A. C. M.

740. *Indirectly Excited Fluorescence Spectra.* **S. Loria.** (Phys. Rev. 26. pp. 573–584, Nov., 1925.)—(1) Repetition of experiments of Franck and Cario.—The illuminated end of the quartz tube containing Tl metal was placed in the hottest part of the furnace to avoid condensation. In the fluorescence spectrum all Tl lines to be expected theoretically, from $2p_1 - 2s$ to $2p_1 - 4d_1$ and $2p_1 - 5d_2$ were identified. This excitation shows that the life of the $2p_1$ state is for Tl atoms of the order of 10^{-6} sec. (2) Enhancing effect of inert gases.—Series of spectrograms with the same tube confirmed the results of Donat. As the pressure of A or N_2 was increased the intensity of λλ5350, 3776 and 2768 increased rapidly, reaching a maximum for 5 to 20 mm. of A or 5 to 10 mm. of N_2. A trace of O_2 neutralises this enhancing effect. (3) Experiment with Tl vapour distilling past the window.—In this case a "negative effect" was observed, the addition of a neutral gas decreasing the fluorescence. This was probably due to the interference of the inert gas on the rate of distillation, and hence on the amount of Tl present near the window. (4) Experiments with closed tubes at uniform temperature.—The enhancing effect was also obtained with these tubes, showing that it cannot be an indirect effect of the interference of the neutral gases with the distillation of the Tl vapour in Donat's experiments, but is definitely associated with the presence of the neutral gas. (More intense fluorescence was obtained with N_2 at 5 mm. and Hg at 0·16 mm. than with N_2 at 8 mm. and Hg at 0·5 mm., the Tl being at 0·45 mm.) (5) Conclusions regarding rôle of Hg atoms in the $2p_3$ state.—These results confirm the assumption of Franck and Donat as to the part the Hg atoms in the metastable $2p_3$ state take in the energy transfer to normal Tl atoms. Comparison of spectrograms at different partial pressures indicates that the metastable Hg atom may survive many collisions with normal A or N_2

molecules, but easily gives up its energy when colliding with normal Tl or Hg atoms, probably more easily to Tl than to Hg. AUTHOR.

741. *The Stark-Effect for Hβ and He λ4686.* **J. S. Foster.** (Astrophys. J. 62 pp. 229–237, Nov., 1925). Hβ.—Components of Hβ under fine analysis are measured in various fields up to 47 kilovolts/cm. Theoretically unexpected components of this line are present in one of the analyses reproduced, and absent in another. From known variations in the character of the sources, and observations on helium mixed with the hydrogen, it is proved that the source which gave the spurious components was confused, and that the applied field was not in the same direction for all atoms. Consequently the p and s components could not be separated completely. The most prominent of the doubtful components, $p \pm 4$, are found to be due to the very strong components $s \pm 4$. It is suggested that in the experiments by Stark the space charge may have been sufficient to cause a similar confusion.

He λ 4686.—At least three components of this line in fine analysis of the Stark effect are clear in an accompanying photograph. The observed spacings are 0·37 and 0·39 Å., the calculated value being 0·33 Å. in each case. Further measurements are prevented by hydrogen band lines. AUTHOR.

742. *The Critical Potential of the Negative Band-Spectrum of Nitrogen.* **E. E. Witmer.** (Phys. Rev. 26. pp. 780–785, Dec., 1925.)—The method used was to photograph the spectrum of the light excited inside an equipotential anode by electrons from a filament distant less than an electron mean free path. The straight filament of tungsten was placed 2 mm. in front of the anode, a nickel pill box which was perforated with numerous holes on the side facing the filament. A rectangular opening in the convex side of the box permitted spectroscopic observation of the glow developed within. Chemically prepared nitrogen at about 0·1 mm. pressure was used and precautions taken to ensure its purity. Using a Hilger constant deviation glass spectrograph, a series of spectrograms was obtained in the region above λ3900 Å. at intervals of a volt from 17·75 to 22·75 volts (corrected) inclusive. The negative bands, which are fairly intense at 22·75 volts, gradually decrease in intensity as the voltage decreases, but on the 17·75-volt spectrogram 4278 is distinctly visible, and there are traces of 4708 and 4236. These results seem to indicate that the negative bands appear as a whole at the ionisation potential of nitrogen or between the ionisation potential and 17·75 volts. AUTHOR.

743. *The Absorption Spectrum of Manganese Vapour in the Visible and Ultra-violet.* **R. V. Zumstein.** (Phys. Rev. 26. pp. 765–770, Dec., 1925.)—With an absorbing column of the vapour about 3 cm. long heated to temperatures between 1200° C. and 1600° C., absorption was observed at 31 lines. Grotrian had previously reported absorption at six of these lines. All of the absorptions are from manganese atoms in the normal state (1^6s term) and occur in groups of 1, 2 and 3 lines. Five absorption lines represent $1^6s - {}^6d'$ combinations for which the rule of inner quantum numbers is obeyed, but the azimuthal quantum number changes by 2. Four lines are $1^6s - {}^8p$ combinations and twelve are $1^6s - {}^6p$ combinations. Some of the remainder are perhaps $1^6s - {}^4p$ and $1^6s - {}^2p$ combinations. AUTHOR.

744. *Compton-Effect.* **J. W. M. du Mond.** (Nature, 116. p. 937, Dec. 26, 1925.)—Reference is made to a new device for the study of the Compton-effect. This is an X-ray tube in which both scattering substance and analysing crystal are contained in a small metal box mounted on the end of the anti-cathode. It has been found possible to produce photographic spectrograms of the Compton-effect with this apparatus in thirty seconds that would by previous methods have required a hundred hours' exposure. The apparatus is considered to be specially useful for the study of high dispersion. A. B. W.

745. *Compton-Effect.* **G. Hagen** and **F. Kirchner.** (Ann. d. Physik, 78. 4. pp. 407–420, and 421–422, Dec., 1925.)—Inadequacy of the Compton-Debye theory discussed. Investigation as to whether monochromatic Röntgen radiation suffers an alteration in wave-length on scattering or not. Compton said " Yes." Duane denied this, but has recently retracted his denial. **Hagen** found that with the shorter wave-lengths there was only an undisplaced line and no trace of a displaced line. **Kirchner** has repeated the investigation, and attributes Hagen's line to a reflection effect. A. D.

746. *Spectroscopic Investigations on the Compton-Effect.* **M. de Broglie** and **A. Dauvillier.** (J. de Physique et le Radium, 6. pp. 369–375, Dec., 1925.)—The object of this paper is to collect in a single paper, and to give further details of, the results of researches on the Compton-effect carried out by the authors and published in the " Comptes Rendus " during the earlier part of 1924. A special X-ray tube is described, particularly adapted to the study of the Compton-effect for rays of long wave-length. The effect is studied as a function of the atomic number of the radiator and of the wave-length of the exciting radiation. It is shown that Compton's theory is completely verified by the experimental results. Consequently the theory of tertiary radiation advocated by various American authors has been proved incorrect. A. B. W.

747. *A Precision Measurement of the Change of Wave-length of Scattered X-Rays.* **H. M. Sharp.** (Phys. Rev. 26. pp. 691–696, Dec., 1925.)—According to the quantum theory, the change of wave-length due to scattering is $\delta\lambda = (h/mc)(1 - \cos\phi)$, where h is the radiation constant, m the mass of an electron, c the velocity of light and ϕ the angle of scattering. In the present experiments ϕ was made as large as possible (169°) by placing the slits and calcite crystal in a lead box fastened to the Coolidge tube. Mo Kα and Kβ radiation was scattered from paraffin back to the crystal and then to a photographic plate; Zr Kα rays for comparison were obtained from a Zr radiator. The best plate required an exposure of 48 hours. The change of wave-length was measured sixteen times by means of a special microphotometer. After certain corrections were made, the shift came out $(0{\cdot}04825 \pm 0{\cdot}0002)$ Å.; the theoretical value is $0{\cdot}04798 \pm 0{\cdot}0001$. This agreement is an excellent confirmation of the theory. This effect may also be used to obtain a measurement of m which is independent of e/m. The value of the mass of the electron thus computed from these measurements is $(8{\cdot}99 \pm 0{\cdot}034) \times 10^{-28}$ gm. in agreement with the mean result from deflection experiments, whereas the spectroscopic value of e/m gives 9·04. AUTHOR.

748. *Relationship of the Observed Degree of Polarisation of the Primary Beam of X-Rays to the Substance used as Scatterer.* **W. Kartschagin** and **E. Tschetwerikowa.** (Zeits. f. Physik, 35. 4. pp. 276–285, 1925.)—In the investigation of the polarisation of a beam of X-rays it is found that the observed degree of polarisation depends on the substance used as analysed. An investigation is described in which a narrow beam falls on a pole-shaped scattering substance, the intensity of the radiation in a plane perpendicular to the direction of propagation of the primary rays being observed. Using a Coolidge tube with a tungsten target run at 26·5 kv. the following results were obtained :—

Substance of Scatterer.	Per Cent. Polarisation observed.
Paraffin	6·6
Aluminium	6·3
Sulphur	5·5
Iron	2·4
Tin	4·5
Lead	8·0

W. V. M.

749. *Soft X-Rays from Certain Metals.* **C. T. Chu.** (Frank. Inst., J. 200. pp. 615–627, Nov., 1925.)—A special type of discharge-tube containing a cylindrical ion trap is described. The observations made were of the photoelectric current from a Ni plate corresponding to a given accelerating potential between filament and target, the latter being of iron, copper, or nickel in the various experiments. The current plotted against potential showed a number of breaks and changes of slope, the latter being interpreted as points at which X-radiation sets in. Thus Ni showed breaks at 49, 75, and 98 volts ; Fe at 52, 68, and 80 ; and Cu at 30, 49, 62, 79, and 90, these values being uncorrected for voltage drop in the filament or for contact potentials. The theoretical interpretation is discussed, but appears incomplete and the results uncertain. The number of breaks may be limited to (*a*) a small number corresponding to the number of orbits, as in the case of hard X-rays ; (*b*) to a greater number of possible transfers into outer virtual orbits similar to the resonance and excitation lines observed in connection with L levels ; (*c*) to a definite number of possible transfers into the incomplete outer shells. The break observed in the neighbourhood of 50 volts in all cases may be due to nickel. W. V. M.

750. *The Fine Structure of Certain X-Ray Absorption Edges.* **K. Chamberlain.** (Phys. Rev. 26. pp. 525–536, Nov., 1925.)—In a recent paper Coster [see Abstract 2521 (1924)] reports a white line on the long wave-length side of the X-ray absorption edge of some metallic oxides. Evidence is here reported which shows that in each case the white line is the absorption edge for some of the material which had been reduced to the metal by the X-ray beam. Screens are prepared by covering black paper with a thin layer of finely divided metal weighing 2 to 3 mg. per cm.^{2}. K-absorption edges for Ti(22), V(23), Cr(24), and Mn(25) are found at 2489·5, 2261·9, 2064·9, and 1891·4 x-units. L_{III} absorption edges for Sn(50), Sb(51), Te(52), and I(53) are 3146·9, 2291·5, 2847·1 (Coster), and 2712 (Coster). These values are all in good agreement (within less than 1 x-unit) with the positions of Coster's white lines. In

the case of compounds of higher valence, the white line Coster obtained is therefore due to reduced element. In the case of sulphides and sulphites the secondary absorption edge at 4988 x-units reported by Lindh may likewise be due to traces of sulphate in the screen produced by the action of the X-rays. Chemical evidence of appreciable reduction of iodic acid and potassium permanganate is presented, and also of the oxidation of sulphurous acid. It is proposed that the numerous electron transitions that follow the removal of an electron from its normal orbit by absorption of radiation may occasionally occur in such a way as to result in a change in the general electron configuration, such that some of the valence electrons find stable positions farther in, thus resulting in a reduction of valence. Oxidation can also occur when the change in the electron configuration is such as to place an increased number of electrons in the valence group. What makes this proposal seem especially reasonable is that Ti(22), V(23), Cr(24), and Mn(25) occur in a portion of the periodic table in which inner groups are being filled in building new elements, while Sn(50), Sb(51), Te(52), and I(53) are found very close to such a group. Bohr thus considers that configurations which place additional electrons in inner groups in this region are stable. A. E. G.

751. *Soft X-Rays from Iron, Cobalt, Nickel and Copper.* **C. H. Thomas.** (Phys. Rev. 26. pp. 739–748, Dec., 1925.)—Critical potentials of Fe, Co, Ni and Co. to 1500 volts.—Using the photoelectric method previously described (Abstract 1659 (1925)], the study of iron has been extended, and critical potentials of Co and Ni have been determined throughout the range 0-1500 volts. The arrangement is more sensitive than that used by previous observers, and readings were taken at intervals of 1/2 volt accelerating potential up to 100 volts and at corresponding small intervals for the higher ranges ; hence the curves are more accurate and reproducible than those obtained by other investigators. Forty-six critical potentials were found for Ni, 48 for Co, and the number for Fe was increased to 46. More than 100 independent curves were obtained for each of these metals, and the breaks reported were entirely reproducible. Copper was investigated only in the range 0–90 and 700–1200 volts ; 25 critical potentials were found. The breaks are of two types, with shapes which suggest that they correspond to ionising and radiating potentials. There is a general correspondence, both in nature and value, between the critical potentials of iron, cobalt, and nickel, with an upward shift of voltage with increasing atomic number. This correspondence is especially striking in the case of the nine breaks which have been designated as " ionising " potentials. In the region of the L series, the critical potentials of copper also correspond accurately with those of the other metals, but in the region 0–90 volts there appears to be no similarity. The critical potentials which could be connected with X-ray spectroscopic terms with some certainty are : Fe, L_I at 818·5 and L_{III} at 704·3 ; Co, L_I at 873·2 and L_{III} at 764·8 ; Ni, L_I at 948·0 and L_{III} at 833·4 ; Cu, L_I at 1017·0 and L_{III} at 929·0 volts. AUTHOR.

752. *The Apparent Shape of X-Ray Lines and Absorption Limits.* **F. K. Richtmyer.** (Phys. Rev. 26. pp. 724–735, Dec., 1925.)—Effect of instrumental factors on the observed intensity distribution of X-ray lines and at absorption limits.—(1) Slit width. In the case of two slits of equal width, sharp lines reflected from a perfect crystal should give

an isosceles triangle distribution. If the two slit widths are unequal, the triangle is truncated; this may shift the relative position of the lines of a partly resolved doublet. (2) Slit height widens the isosceles triangles slightly, making the long-wave-length side less steep. (3) Non-uniform energy distribution over the focal spot produces corresponding lack of symmetry. An actual distribution curve obtained with very narrow slits showed two unequal maxima near the edges of the spot. The same three factors affect the apparent sharpness of the absorption limit. In particular, the finite slit width results in the rounding off of a sharp discontinuity into a skew-symmetrical **S** curve consisting of parts of two parabolas whose axes are vertical and separated a distance equal to the angular slit width.

Intensity distribution in the Kα doublet of Mo.—The curves correspond to monochromatic lines of width 0·0003 Å. or less. The relative intensity is very close to 2 (2·01). There is no line between them with intensity greater than 1 % that of Kα_1.

Sharpness of the K absorption limit of Ag.—The curve obtained agrees with that for a limit which is sharp within experimental error, 0·0002 Å. AUTHOR.

753. *A Reinvestigation of the Wave-lengths and Relative Intensities in the Molybdenum K Series X-Ray Spectrum.* **S. K. Allison** and **Alice H. Armstrong.** (Phys. Rev. 26. pp. 701–713, Dec., 1925.)—The X-ray beam from a water-cooled target of a tube carrying 25 milliamps. from a 50-kv. storage battery, was limited to two minutes, and reflected from a calcite crystal of a spectrometer with a Genevoise scale reading to two seconds, into an ionisation chamber. The 3rd to 5th orders were used. The angle of reflection for each wave-length was determined by readings on both sides of the direct beam. Corrections were applied for the temperature of the crystal above 18°, for the eccentricity of the scale and for refraction. The wave-lengths are found to be (taking $d = 3·028$ Å.) : $\alpha_2 = 0·711835$, $\alpha_1 = 0·707525$, $\beta_3 = 0·631354$, $\beta_1 = 0·630791$, $\gamma = 0·619526$. From three to five determinations were made for each line, the average deviation from the mean being 0·000025. The mean deviation from the last results of A. Leide is 0·00003 except for β_1, for which his value seems too high. The separation $\beta_3 - \beta_1$ is 0·000563 in good agreement with the separation $L\beta_3 - L\beta_4$ determined by Coster. The wave-lengths taking $d = 3·02904$ Å. and the ν/R and $\sqrt{\nu/R}$ values for the K lines and for the corresponding energy levels in the Mo spectrum are also given. The K absorption limit was found at 0·61830 Å. Assuming each component of the β doublet to be a single line of the same width, the relative intensities come out $K\beta_1/\beta_3 = 2·0$, in agreement with the theoretical predictions of Sommerfeld and of Coster and Goudsmit. In the case of the β and γ doublets the total intensity of each doublet was taken proportional to the area under it, correcting for the K absorption in the case of the γ peak. The relative intensities then come out $K\beta/\gamma = 7·7$, which is greater than the corresponding ratio for tungsten, indicating a decrease with increasing atomic number. AUTHORS.

754. *Experiments on the Relative Intensities of Some X-Ray Lines in the L Spectrum of Tungsten and the K Spectrum of Copper.* **S. K. Allison** and **Alice H. Armstrong.** (Phys. Rev. 26. pp. 714–723, Dec., 1925.)—Tungsten L-series lines.—The experiments of Duane and Patterson on

the strong lines in the L-series of tungsten were repeated with improved apparatus, and also some of the weaker lines were studied. The value 10 obtained by Duane and Patterson for the relative intensity of $L\alpha_1$ to $L\alpha_2$ was confirmed. The theoretical ratio is 9. For the β group the relative intensities were found to be, $\beta_1 : \beta_2 : \beta_3 : \beta_4 : \beta_5 : \beta_6 : \beta_7 : \beta_9 : \beta_{10} = 100 : 49{\cdot}3 : 15{\cdot}0 : 7{\cdot}7 : 0{\cdot}47 : 2{\cdot}0 : 0{\cdot}4 : 0{\cdot}68 : 0{\cdot}60$. The relative intensities of the weak lines among themselves are not very reliable on account of the faintness of the lines and the critical absorption of the target, yet it is clear that the forbidden lines β_9, β_{10} are of the same order of intensity as β_5, β_7. For the γ group the relative intensities were found to be, $\gamma_1 : \gamma_2 : \gamma_3 : \gamma_4 : \gamma_5 : \gamma_6 : \gamma_8 = 100 : 14{\cdot}0 : 22{\cdot}3 : 7{\cdot}0 : 3{\cdot}0 : 2{\cdot}3 : 1(?)$. γ_8 could not always be obtained. The determination of the intensity ratios for α_1, β_1 and β_2, γ_1 was complicated by absorption in the target. The agreement of the observed value of the intensity ratio for β_3/β_4 with the theoretical value 2, tends to confirm Stoner's suggestion that there are twice as many electrons in the M_{22} orbit as in the M_{21}. The deviation of the observed intensity ratio for γ_3/γ_2 from 2 may be due to the influence of intervening levels.

Copper K-series lines.—The average of two determinations of the relative intensity of β to γ gave 100/2·4. No reliable evidence of the non-diagram lines $K\alpha_3\alpha_4$ was obtained at 30,700 volts. AUTHORS.

755. *The Direction of Ejection of Photoelectrons produced by X-Rays.* **D. H. Loughridge.** (Phys. Rev. 26. pp. 697–700, Dec., 1925.)—Stereoscopic photographs of photoelectrons produced by 40-kv. Mo Kα X-rays, were examined by a stereoscopic comparator which gave a quantitative measure of the initial direction of ejection in space. The measurement of 24 distinct tracks in a series of 29 pairs of photographs showed that the most probable angle of ejection was about 70° with the primary beam. This supports the view that the electric vector of the radiation plays a very important part in the production of photoelectrons. The small forward or backward component, noticed in many tracks, must come from the random momentum of the electron in its orbit before ejection. AUTHOR.

756. *The Natural X-Ray Spectrum of Radium B.* **E. Rutherford** and **W. A. Wooster.** (Cambridge Phil. Soc., Proc. 22. pp. 834–837, Nov., 1925.)—Measurements were made using rotating crystals of rock-salt and calcite, and tables are given showing the separation of the α_1 and β_1 lines of the L spectrum recorded on the two sides of the photographic plate, the separations deduced for atomic numbers 83 and 82 and those measured for lead X-rays, lead being an isotope of radium B, having the atomic number 82 and giving the separations calculated for that atomic number. The separations for radium B corresponded in all cases to atomic number 83, the values being identical in the observations taken with the calcite crystal, which is more regular than rock-salt.

H. N. A.

757. *A High-vacuum Spectrograph for X-Ray Measurements and Some Preliminary Results.* **R. Thoraeus** and **M. Siegbahn.** (Ark. f. Mat Astron. och Fysik, Stockholm, 19. 12. [19 pp.], 1925. In English.)—A description of a high-vacuum spectrograph which is in direct communication with the Coolidge tube and hence evacuated to the same extent, an

arrangement necessitating certain alterations in its construction. The arrangement which avoids the use of absorbing windows allows of the registration of very long wave-lengths. The filament of the tube is coated with oxide, thus avoiding deposition of W on the target and also the fogging of plates by the light of the filament. A crystal of palmitic acid ($2d = 71{\cdot}19$ Å.U.) is used and the following results are obtained :—

Element.	Kα (Å.U.).	Element.	Lα.	Lβ.
F	18·37	Fe	17·60	17·27
		Mn	19·48	19·17
		Cr	21·69	21·35

An interesting result is that Kα only is observed and not $K\beta_1$, a result to be anticipated on the Bohr theory. Hence the limit of $K\beta_1$ is Ne.

W. V. M.

758. *Duration of an X-Ray Pulse.* **F. Kirchner.** (Ann. d. Physik, 78. 3. pp. 277–304, Nov., 1925.)—Using a modification of Weichert's method for the direct measurement of kathode-ray velocities the author has attempted to determine the duration of emission of a single X-ray pulse. It has been found that the time involved for this emission in the wave-length region near 2 Å. units (the K-radiation from iron) together with the emission of photoelectrons is less than 4×10^{-10} sec. A. B. W.

759. *Laboratory for Precision X-Ray Research.* **Alice H. Armstrong** and **W. W. Stifler.** (Optical Soc. America, J. and Rev. Sci. Inst. 11. pp. 509–517, Nov., 1925.)—The paper describes briefly an X-ray installation design by Duane and fitted in the Cruft High Tension Laboratory. The equipment is discussed under three main headings, *viz.* high power plant, spectrometer and accessories, and auxiliary apparatus. A battery of accumulators can be arranged to give 50,000 volts, and eventually over 100,000 volts will be available. The insulation of this battery is described. A. B. W.

RADIO-ACTIVITY.

760. *Uranium X : Its Extraction and Estimation.* **R. De.** (Sci. Assoc. Maharajah's Coll., Vizianagaram, J. 2. pp. 43–52, Oct., 1925.)—A method is described for the separation of Ur X from uranyl salt, a modification of McCoy's method [Abstract 715 (1906)] being employed for the estimation of this substance by comparison with the β-activity of Ur_3O_8. A. B. W.

761. *The Action of Sunlight on the Radio-activity of Lead and Uranium.* **(Miss) S. Maracineanu.** (Comptes Rendus, 181. pp. 774–776, Nov. 23, 1925.)—The substances were either exposed directly to the sun's rays, or a lens was employed to concentrate these to a focus on the surface. Lead which was inactive before this treatment was rendered radio-active and produced an impression on a photographic plate some hours or even days after the exposure ; it also caused a few strong scintillations on a zinc

sulphide screen: these were visible several months after exposure. The lead also caused a small ionisation current, the intensity of which corresponded to the restricted number of scintillations, and not to the strong photographic action sometimes produced. The small irregular variation previously observed by Mme. Curie in the activity of uranium is greatly increased in uranium oxide powder when this is exposed to sunlight, rising sometimes to 50 % of the original activity. Curves are given showing the variations from day to day. H. N. A.

762. *The Energy liberated by Radium.* **R. W. Lawson.** (Nature, 116. pp. 897–898, Dec. 19, 1925.)—The author shows that there are considerable differences between the estimates of the energy of the γ-rays emitted by radio-active substances. Calculations involve a knowledge of Z, the number of atoms disintegrating per sec. per gramme of the element. In the case of radium without its disintegration products the conditions for the calculation of the total heating effect, H, due to 1 gramme are simplified, since radium does not emit primary β-particles, and the γ-radiation is homogeneous; adding to the calculated energy of the γ-rays that due to the α- and recoil particles, and using Geiger's value for Z, $3{\cdot}40 \times 10^{10}$, it is found that H = 23·28 cal./hour, or with the Hess-Lawson value, $Z = 3{\cdot}72 \times 10^{10}$, H = 25·47; the experimental value of H is 25·2 cal./hour. It is shown that the correct experimental value cannot really differ much from 25·5 cal./hour, so that the value $Z = 3{\cdot}72 \times 10^{10}$ appears to be essentially correct. H. N. A.

763. *The Mobility of the Ions of the Active Deposits of Thorium and Radium.* **H. A. Erikson.** (Phys. Rev. 26. pp. 629–632, Nov., 1925.)—The method used is the same as in a similar study of the active deposit of actinium [see Abstract 1186 (1925)]. As in the case of actinium, two positive active bodies differing in mobility were found in the active deposits of thorium and radium. In the case of these three deposits, all of the three swifter bodies have equal mobilities in air, and, likewise, all of the three slower bodies. The curves obtained indicate that one of the active bodies is not deposited as an A product and the other as a B product; nor is one ion atomic and the other polyatomic. It is believed, however, that one is singly and the other doubly charged. AUTHOR.

764. *Chemical Action of Penetrating Radium Rays.* **A. Kailan.** (Akad. Wiss. Wien, Ber. 133. 2a. No. 9–10. pp. 477–489, 1924.)—In former papers [Abstracts 286 and 1210 (1924)], the author has described investigations of the action of penetrating rays from Ra on solutions of ferric and ferrous sulphates, silver nitrate, calcium chloride and chlorate, calcium persulphate and sulphate and sulphuric acid. The investigation is now extended to include the action of Ra rays on calcium bichromate, calcium chromate and calcium permanganate. The radium preparation employed was equivalent to 110 mg. of Ra metal. Solutions of the above-mentioned compounds were exposed to the rays for a period of two months and a determination of the reducing action made in each case. A. B. W.

765. *Registration of Penetrating "High-Level" Radiations at Sea-Level.* **G. Hoffmann.** (Phys. Zeits. 26. pp. 669–672, Nov. 3, 1925. Paper read before the Deut. Physikertag., Danzig, Sept., 1925.)—Using

the apparatus previously described by him, the author has measured the ionisation produced inside the chamber with walls 2 mm. thick 4·70 J, with a 3-cm. lead armouring 1·56 J, and with 12 cm. of lead 1·00 J; a much thicker lead armouring has now been employed, total thickness 32 cm., and it was calculated that the ionisation would be reduced to 0·65 J; it was, in fact, only reduced to 0·96 J. It is shown that the formula to be employed when a radio-active material outside the armouring is distributed all round it is quite different from that which is correct when it is concentrated at one point, and as a result the author concludes that some of the radiation which penetrates 12 cm. of lead, but is cut off by 32 cm., may be a very hard RaC-γ-radiation, and some may be a thorium radiation; in that case it is not necessary to assume that a "high-level" radiation penetrates to the sea-level. Considering the high-level observations, it is pointed out that the absorption of γ-rays is a very complicated process, the apparent absorption being made up of Compton scattering and true absorption, the latter depending on the atomic number of the absorber, and being very large as compared with the scattering in the case of lead, while the reverse is the case for air and water (ice). It seems probable that the ionisation at great heights may be explained by hard radiations from known radio-active elements. H. N. A.

766. *A Rapid and Accurate Method of Correcting Measurements with Emanation Electroscopes for Ordinary Changes in Temperature and Pressure.* **O. C. Lester.** (Optical Soc. America, J. and Rev. Sci. Inst. 11. pp. 637–640, Dec., 1925.)—Errors due to these variations are usually neglected though they may amount to 3 or 4 % in measurements claimed to be accurate to within 1 %. Assuming that an electroscope has been standardised at a given pressure and temperature, it is shown that the necessary calculations can be made once for all. From these calculations a chart is constructed by means of which the constant of the electroscope, corresponding to other values of the temperature and pressure, can be obtained graphically by a single reading. AUTHOR.

767. *Note on the Geiger Counter.* **W. Kolhörster.** (Phys. Zeits. 26. pp. 732–734, Dec. 8, 1925.)—The author uses closed counters, the opening being shut off with a thin sheet of aluminium or mica, the thickness of which is equivalent to a few centimetres of air. The counters generally worked best when the pressure in the interior was reduced. While Wulf has endeavoured to simplify the apparatus by using high voltages, with open counters, the author uses low voltages (450–700 volts), which are possible when the pressure is reduced to 10–20 mm. Hg. H. N. A.

768. *Reply to W. Kolhörster's Note on the Geiger Counter.* **T. Wulf.** (Phys. Zeits. 26. p. 734, Dec. 8, 1925.)—The author considers that the method employed by him is preferable, for demonstration purposes, to that described by Kolhörster [see preceding Abstract]. There is no difficulty in obtaining the voltages required, while with a closed chamber for the counter it is difficult to change the point when necessary. H. N. A.

769. *Scattering of α-Particles by Atomic Nuclei, and the Law of Force.* **E. Rutherford** and **J. Chadwick.** (Phil. Mag. 50. pp. 889–913, Nov., 1925.)—Describes apparatus used in measuring the scattering of α-particles

by thin foils of different metals at average angles of 135° and 90°. The results obtained were indicated by Rutherford in a lecture before the Royal Institution [see Abstract 1678 (1925)]. With gold the experiments at 135° showed that the scattering obeyed the law of inverse square for α-particles of ranges from 6·7 to 2·4 cm., and prove that the gold nucleus behaves as a point charge of $79e$ for distances of approach between $3{\cdot}2 \times 10^{-12}$ and 10^{-11} cm. Experiments on uranium indicate that the scattering of 6·7-cm. particles is normal to within about 20 % ; this would indicate that the charge on that part of the U nucleus which lies within about 4×10^{-12} cm. of the centre is within 10 % of the normal nuclear charge. The radio-active behaviour of uranium may be taken as indicating that the radius of the nucleus is not less than 7×10^{-12} cm. If satellites are present at such a distance in the gold nucleus both positive and negative must be present, of about equal total charge. The fact that for magnesium and aluminium the ratio of the observed to the inverse square scattering at 135° is a minimum when the range is about 5 cm. is discussed, and various hypotheses which attempt to account for it are mentioned, including that of Bieler. It is suggested that the facts may be accounted for if the nucleus is a charged central core, surrounded by a satellite distribution of negative charges on an inner shell, and one of positive charges on an outer shell. H. N. A.

770. *Theory of the Range of Alpha-Particles.* **L. Loeb** and **E. Condon.** (Frank. Inst., J. 200. pp. 595–607, Nov., 1925.)—Henderson has attempted to apply quantum conditions in calculating the loss of energy of the α-particle to the electrons in the atom, and concluded that there was fairly close agreement between theory and observation. The authors show that Henderson, Fowler and Bates have assumed that all the n_s electrons, having an ionising potential T_s, that lie within a distance p_s of the path of the α-particle such that the energy communicated according to the classical theory corresponds to the ionising potential, will be ionised and will receive energy amounting to T_s or more. This would be correct if the n_s electrons could be regarded as independently distributed at random along the path of the α-particle, but as a matter of fact they are related to one another, a number of them forming parts of a single atom. To remove two electrons from the same level requires more than twice the energy required for one, and to remove two of different groups in the same atom more than the sum of the energies required to remove each electron separately ; thus a large error may be introduced. The computed range in helium becomes 58 cm. as compared with that derived from the Henderson theory, and 23·6 cm. as found experimentally. The conclusion is that the error lies in the application of dynamics to the problem, and it is quite probable that the error is due to assuming electrons which are initially at rest and free in deriving the theory. H. N. A.

771. *Alpha-particles of Long Range from Radio-active Substances.* **Irène Curie** and **N. Yamada.** (J. de Physique et le Radium, 6. pp. 376–380, Dec., 1925.)—An apparatus is described for the counting of long-range α-particles. Instead of absorbing screens usually employed, the authors use gas under pressure—the α-particles being observed by the usual microscope-scintillation method. The proportionality of range to inverse pressure has been verified for ThC α-particles in air, O_2 and

CO_2 up to 3 or 4 atmospheres. A method is indicated to determine the ratio of the long-range to ordinary-range α-particles. A. B. W.

772. *Long-range α-Particles from Polonium and the Active Deposits of Thorium and Radium.* **N. Yamada.** (J. de Physique et le Radium, 6. pp. 380–389, Dec., 1925.)—A brief summary is given of the work of earlier investigators on this subject, notably Marsden and Perkins [Abstract 1429 (1914)], Rutherford and Wood [Abstract 689 (1916)], Wood [Abstract 1277 (1921)], Bates and Rogers [Abstract 1501 (1924)], and Pettersson [Abstract 1615 (1925)]. A scintillation method is now employed, and a study is made of the effect of varying the conditions of preparation of the active surface. In the case of polonium, no α-particles of long range were observed. With active deposit of thorium a group of α-particles of range 11·5 cm. in air was observed in the proportion of 2·9 per 10^4 α-particles of 8·6 cm. range. Radium active deposit was found to emit a group of α-rays of range 9·3 cm. in air, in the proportion 20 per 10^6 α-particles of 7 cm. range. All other groups of rays, observed by Bates and Rogers, do not appear to exist. A. B. W.

773. *Theory of the Number of Beta-Rays associated with Scattered X-Rays.* **G. E. M. Jauncey** and **O. K. DeFoe.** (Phys. Rev. 26. pp. 433–435, Oct., 1925.)—In a recent paper by Compton and Simon [see Abstract 1669 (1925)] the ratio of the number of recoil electron tracks to that of photoelectron tracks has been found equal to the ratio of scattering coefficient σ to true absorption coefficient τ for short wave-length X-rays, as predicted by Compton and Hubbard, but for long wave-lengths the experimental ratio is distinctly smaller. In the present paper a correction factor is applied to σ/τ by taking into account the motion and the binding energy of the scattering electron in its Bohr orbit and also the minimum energy which the recoil electron must have in order to produce a visible track in a Wilson cloud apparatus. Assuming a minimum energy of 630 volts for a recoil electron to produce a visible track, the correction factor for a primary wave-length of 0·71 Å. is 0·36, thus making the theoretical value of the ratio of recoil to photoelectron tracks 0·097 as against an experimental value of 0·10. For other wave-lengths the agreement is equally good. AUTHORS.

774. *The β-Ray Spectrum of the Natural L-Radiation.* **D. H. Black.** (Cambridge Phil. Soc., Proc. 22. pp. 832-833, Nov., 1925.)—Examining the β-ray spectrum due to the disintegration of radium B the author concludes that the electrons are ejected by L X-rays from an atom whose atomic number is 83, acting on the M, N and O levels of the same atoms, the atomic number of radium B being 82. H. N. A.

775. *The Analysis of the β-Ray Spectrum due to the Natural L Radiation of Radium B.* **D. H. Black.** (Cambridge Phil. Soc., Proc. 22. pp. 838–843, Nov., 1925.)—Using values for $H\rho$ and V (volts $\times 10^{-3}$) for the observed lines of the β-ray spectrum, which differ a little from those given in a previous paper [see preceding Abstract] a table has been prepared in which the energies for exciting rays $L\alpha_1$, $L\beta_1$ and $L\gamma_1$, acting on the various M, N and O levels, are calculated for atomic numbers 82 and 83 and compared with the energies of the observed lines. The agreement for atomic number 83 is far better than for 82. Taking the latter number, it is only possible to account for six of the observed lines, none of which

is at all strong; taking 83 it is possible to account for 11 out of the 15 lines observed, including all the stronger ones and neither of the two doubtful ones; the intensities agree on the whole with those found by Robinson in his X-ray measurements. These results strongly support the hypothesis that electrons are ejected by γ-rays *after* the nuclear change has taken place. The corresponding corpuscular spectrum of thorium B is practically the same as that of its isotope radium B, which confirms the above hypothesis. H. N. A.

776. *The β-Ray Type of Disintegration.* **C. D. Ellis** and **W. A. Wooster.** (Cambridge Phil. Soc., Proc. 22. pp. 849–860, Nov., 1925.)—The paper deals with the general problem of β-ray disintegration in view of recent direct experimental evidence that in a β-ray disintegration the γ-rays are emitted after the electron has been ejected from the nucleus. The first section of the paper deals with the question of the moment of emission of the γ-rays, and the second and third with the question of the mechanism of emission of the γ-rays and of the disintegration electron respectively. A. B. W.

777. *The β-Ray Spectra of Radio-actinium and its Disintegration Products.* **O. Hahn** and **L. Meitner.** (Zeits. f. Physik, 34. 11–12. pp. 795–806, 1925.)—Radio-actinium was prepared free of all disintegration products, and its β-ray spectrum was photographed. New photographs were taken at various time intervals, and showed the gradual growth of new lines due to actinium X and active deposit and the fading of the original lines; it was possible in this way to identify the lines of actinium X in the mixed spectrum, and the identification was confirmed by preparing by a suitable chemical process actinium X + active deposit, and photographing its β-ray spectrum, and finally by obtaining the spectrum of the active deposit alone. Forty-nine lines have been identified and measured belonging to radio-actinium, and twenty-one to actinium X. The results for the active deposit are still incomplete, as the lines observed were faint; nine of them have been measured. The rich β-ray spectra of the first two substances, both of which are α-radiators, indicates intensive and complex γ-ray spectra. The theoretical bearing of the observations is discussed in a separate paper by L. Meitner [see Abstract 782(1926)]. H. N. A.

778. *Number of β-Particles in β-Ray Spectra of RaB and RaC.* **R. W. Gurney.** (Roy. Soc., Proc. 109. pp. 540–561, Nov. 2, 1925.)—The β-particles from RaB and RaC have been examined quantitatively by the magnetic spectrum method. The particles were focused on a slit, below which was placed a Faraday cylinder, so that the actual number of particles emitted with any velocity could be measured and the solid angle of the beam known. Preliminary experiments were sufficient to prove that the so-called continuous spectrum of the β-rays from RaB and RaC was genuine. Further observations indicated also: (1) The continuous spectrum of RaB rises to a maximum at 170,000 volts and has an upper limit at about 650,000 volts. The spectrum of RaC rises to a maximum at about 400,000 volts and has a definite upper limit at 3,150,000 volts. Curves showing the velocity distribution are given. (2) If the continuous spectrum is formed by the electrons ejected from the nucleus one would expect the spectra of RaB and RaC (including the β-ray lines) to contain rather more than one electron for each atom disintegrating. By integrating the number of particles in the spectrum

this is found to be the case for both RaB and RaC. (3) By measuring the five peaks on the spectrum-curve the actual number of particles in the β-ray lines of RaB are found. From this it is calculated that the probability of a gamma-ray being converted into a β-ray instead of escaping from the radio-active atom is about 1 in 7. (4) By integrating the energy carried by the particles in the spectrum the heating effect for the β-particles of RaB + C is found to be 5·6 calories per hour per gramme. Of this 1·3 calories is to be ascribed to RaB and 4·3 calories to RaC. A. B. W.

779. *Absorption of β-Rays by Matter.* (**Mrs.**) **J. S. Lattès** and **G. Fournier.** (Comptes Rendus, 181. pp. 855–856, Nov. 30, 1925.)—The authors have determined the mass-absorption coefficient of secondary β-rays produced by radium primary γ-rays in the following substances: C, Al, Ag, Pt, Au, Pb. The results satisfy accurately the relation $\mu'/\rho = 5·73 + 0·0547N$.

Substance.	Atomic Number.	μ'/ρ Observed.	μ'/ρ from Formula.
Carbon	6	6·0	6·06
Aluminium	13	6·4	6·44
Silver	47	8·3	8·30
Platinum	78	10·0	10·00
Gold	79	10·1	10·05
Lead	82	10·3	10·22

A. B. W.

780. *The Continuous Spectrum and the Spectrography of γ-Rays.* **A. Piccard.** (J. de Physique et le Radium, 6. p. 334, Oct., 1925.)—A brief note referring to the limiting wave-length in the continuous γ-ray spectra observed by J. Thibaud [Abstract 1917 (1925)]. The author explains Thibaud's observations on the grounds of the absorption of secondary rays in the secondary radiator itself. A. B. W.

781. *Secondary Spectra of γ-Rays—Origin of the Lower Limit of the Continuous Spectrum and the Variation of Relative Intensity of the Rays.* **J. Thibaud.** (J. de Physique et le Radium, 6. pp. 334–336, Oct., 1925.)—The author attempts to explain the origin of the limit of the continuous spectrum by the effect of the absorption of the corpuscles in the secondary radiator. A formula is deduced for the case of an aluminium screen. Important differences are noted of relative intensity in neighbouring β-rays in the ordinary and incited spectra. A. B. W.

782. *γ-Rays of the Actinium Series—Emission of γ-Rays after the Disintegration of the Atom.* **L. Meitner.** (Zeits. f. Physik, 34. 11–12. pp. 807–818, 1925.)—It is shown when the emission of secondary β-rays from the parent atom precedes the disintegration of the nucleus, then the emission of γ-rays must follow the disintegration. In the case of the β-ray spectra of RaAct. and Act. X it is shown that the so-called photo-effect takes place in the parent atom; the γ-radiation is emitted after the emission of α- (or β-) particles. The author gives in tabular form the energies and wave-lengths of the γ-rays from RaAct., Act. X and Act. C″ [see Abstract 777 (1926)]. A. B. W.

HEAT.

783. *Thermal Expansion of Jena-glass.* **F. P. G. A. J. van Agt** and **H. K. Onnes.** (K. Akad. Amsterdam, Proc. 28. 7. pp. 667–673, 1925. Comm. No. 176A from the Phys. Lab., Leiden.)—The thermal expansion of Jena-glass 16^{111} at low temperatures was measured by observations upon the position of platinum points sealed into both the bottom and top of the inner and outer walls of a vacuum vessel. The outer wall was maintained at room-temperatures whilst the inner was cooled to the boiling-point of ethylene, oxygen and hydrogen respectively. The results show that at low temperatures α_t does not vary linearly with the absolute temperature but shows the character of the specific heat. It is probable that for most substances the form of the expansion-coefficient curve is the same as for glass and is nearer to that predicted by the Lindemann theory than to that predicted by Debye. W. H. GE.

784. *Thermal Expansion of Tungsten.* **P. Hidnert** and **W. T. Sweeney.** (Bureau of Standards, Sci. Papers, No. 515. pp. 483–487, 1925.)—This paper gives the results of an investigation on the thermal expansion of tungsten (99·98 %) over various temperature ranges between − 100 and + 500° C. A summary of available data obtained by previous observers on the thermal expansion of tungsten is included. The expansion of tungsten is given by the following empirical equation :

$$L_t = L_0[1 + (4{\cdot}28t + 0{\cdot}00058t^2)10^{-6}]$$

where L_t represents the length of the metal at any temperature t between − 105 and + 502° C., and L_0 the length at 0° C. Average coefficients of expansion for various temperature ranges are given in a table.

AUTHORS.

785. *Thermal Conductivity of Solid Bodies at Low Temperatures.* **A. Eucken.** (Zeits. techn. Physik, 6. 12. pp. 689–694, 1925.)—Some of the more important results of measurements of the thermal conductivity of solid non-metals are compared and tabulated. The Debye theory of the thermal conductivity of solid bodies is discussed with a view to testing the possibility of its leading to further experimentally verifiable consequences, and some of the more recent results in the domain of the thermal conductivity of metals are briefly reviewed. A bibliography is appended.

E. F.

786. *A Generalisation of Fowler's Distribution Statistics.* **W. Schottky.** (Ann. d. Physik, 78. 5. pp. 434–438, Dec., 1925.)—This is a short paper in which the author suggests a generalisation of Fowler's distribution statistics to cover the case of a partial vaporisation of a component from a multi-component system. No mathematical proof is given. T. B.

787. *Influence of Thin Surface Films on the Evaporation of Water.* **E. K. Rideal.** (J. Phys. Chem. 29. pp. 1585–1588, Dec., 1925.)—The

relative rates of evaporation of water from clean surfaces and from surfaces covered with films of stearic, lauric, and oleïc acids respectively are experimentally determined. The tabulated results show that, contrary to the conclusions arrived at by Hedestrand [see Abstract 614 (1925)], the rates of evaporation from the film-protected water surfaces are found to be much slower than from a clean water surface. An increase in surface concentration or film pressure retards the rate of evaporation, whilst both condensed and expanded films exhibit this characteristic to similar extents. The lack of agreement with Hedestrand's results may be attributed to the different methods adopted for the removal of evaporated water. Whilst Hedestrand used the air-stream method, evaporation is, in the present work, carried out under reduced pressure.
A. B. C. L.

788. *Partial Pressures of Water Vapour and of Sulphuric Acid Vapour over Concentrated Solutions of Sulphuric Acid at High Temperatures.* **J. S. Thomas** and **W. F. Barker.** (Chem. Soc., J. 127. pp. 2820–2831, Dec., 1925.)—The values previously obtained for the partial pressures of sulphuric acid [Abstract 898 (1924)] are erroneous, owing to adsorption of acid vapour on the glass wool employed to prevent mechanical transference of the liquid. The apparatus previously used, modified to eliminate this and other errors, has now been employed to determine the partial pressures of the water vapour in contact with acid-water mixtures containing from 89 to 99·3 % of sulphuric acid at temperatures ranging from 180° to 300°. It is found that both the water and the sulphuric acid partial pressures, and also the total pressure, may be represented by Rankine's equation, $\log p = \alpha - \beta/T - \gamma \log T$, and the values of the various constants have been calculated. The boiling-points deduced from the total pressure by extrapolation are considerably too high, but if complete dissociation of the sulphuric acid vapour is assumed good agreement with the accepted values is obtained. T. H. P.

789. *Relation between the Viscosity and the Vapour-Pressure of Binary Mixtures.* **N. A. Yajnik, M. D. Bhalla, R. C. Talwar,** and **M. A. Soofi.** (Zeits. phys. Chem. 118. pp. 305–317, Dec. 30, 1925. From the English.)—In extension of a principle found by Porter to apply to liquids of single compounds, the viscosities and vapour-pressures of two binary mixtures are considered over a large temperature range, and the temperatures T and T_0 are found at which the vapour-pressures of the respective mixtures are equal. If a graph is plotted giving the relation of their absolute temperatures T/T_0 against the absolute temperature T of one of the mixtures a straight line is obtained, or $T_0/T - T_0'/T' = C(T' - T)$ where T_0 and T are temperatures of equal vapour-pressures for the two liquids, and T_0' and T′ two other temperatures of equal vapour-pressures. The same relation applies to the viscosities of the same mixtures. An examination is made of the vapour-pressures and viscosities of a large number of binary mixtures which are classified into three groups according to whether the mixtures give a linear relation or maxima and minima in the change of vapour-pressure with composition. In cases where the change of vapour-pressure with composition passes through a minimum the viscosity gives a maximum, and conversely where the vapour-pressure passes through a maximum the viscosity shows a minimum. The different formulæ derived to express the viscosity of mixtures are not applicable

to liquids other than those which show a linear change with composition. With this class of mixtures the Bingham formula is found to agree closely and the Arrhenius formula approximately. J. N. P.

790. *Determination of the Vapour-Pressure of Carbon.* **H. Alterthum** and **F. Koref.** (Zeits. Elektrochem. 31. pp. 658–662, Dec., 1925.)—A comparison is made of the vapour-pressure curve of carbon obtained by the arc-light method and that derived from deductions from the values obtained by measurement of the velocity or rate of vaporisation. The difference existing between these curves so obtained can be partially explained by the variations in construction of the crystal surface, but to a far greater extent the discrepancies are due to the existence of an adsorption layer of high concentration which is proportional to the vapour-pressure. From the data obtained in this paper the Knudsen "accommodation coefficient," the vapour-pressure curve of the adsorption layer, and the heat of adsorption of carbon (L) can be calculated. For the range from 2000° to 3500° the value of L is given as 51,900 calories/molecule, or approximately two-fifths of the molecular heat of vaporisation. The values for other ranges are given, and the paper contains full tables and curves of results in support of the conclusions drawn. S. G. B.

791. *Vapour-Pressures of Metals; A New Experimental Method.* **W. H. Rodebush** and **A. L. Dixon.** (Phys. Rev. 26. pp. 851–858, Dec., 1925.)—To determine accurately the vapour-pressures of the less volatile metals a method was evolved which approaches static conditions and renders possible the attainment of a much more uniform and exact temperature in the apparatus. The theory of the method is dealt with fully and tests gave values for the vapour-pressure of mercury from 170° to 203° C., only 0·04 mm. greater on the average than those of Smith and Menzies. For lead the vapour-pressure was measured between 1118° and 1235° C. and the results agree well with the equation, which also fits the best results of Egerton at lower temperatures. The heat of vaporisation of lead at its melting-point from the Clapeyron relation gives 46,300 cal. while the chemical constant comes out as − 1·40, which, within the experimental limits of error, agrees with the value − 1·59 computed from the quantum theory of monatomic gases. R. S. R.

792. *Vapour-Pressure Lowering as a Function of the Degree of Saturation.* **I. Bencowitz.** (J. Phys. Chem. 29. pp. 1432–1452, Nov., 1925.)—Following a review of previous work on the subject, it is shown that attempts to express the vapour-pressure of a liquid in equilibrium with its vapour as a function of the temperature have not been successful. It is suggested that the degree of saturation is a fundamental method of expressing concentration and should be used in the study of the theory of solution wherever possible. Using this method, a relation is arrived at which gives the vapour-pressure lowering, ΔP, as a function of the absolute temperature, T, and the degree of saturation, S, or indirectly the solubility. This equation has the form

$$\log \Delta P = [K \cdot 1/T - a\{1 - (\log S)/b\}]$$

where K, a and b, are constants, and is found to hold for thirty-one substances, for which the values of the three constants are tabulated. It is deduced that the value of the ratio of the vapour-pressure lowering

at any degree of saturation to that of a saturated solution at a given temperature is independent of the temperature; and that the value of this ratio is a simple function of the degree of saturation, *i.e.* $\Delta P/\Delta P_s = S^{K a/b}$. A. B. C. L.

793. *Mercury Vapour-Pressure at Low Temperatures.* **F. E. Poindexter.** (Phys. Rev. 26. pp. 859–868, Dec., 1925.)—Mercury vapour-pressure, 20° to − 80° C.—A modified Buckley ionisation gauge is described with a range from 10^{-2} to 4×10^{-9} mm. This was used to measure the vapour-pressure of mercury. Correction for thermal effusion was made, ranging from 25 % at − 80° C. to zero at 0° C. The gauge was calibrated at 0° C. from Knudsen's value. The results correspond to the equations $\log_{10} p$ (liquid) $= 8{\cdot}86 - 3{\cdot}44(10^3/T)$; $\log_{10} p$ (solid) $= 9{\cdot}35 - 3{\cdot}55(10^3/T)$. Heat of vaporisation of mercury, 20° to − 80°.—From a large-scale plot of $\log p$ against $1/T$ the heats of vaporisation were calculated from the relation $\lambda = - R d(\log p)/d(1/T)$. Above the melting-point the results correspond to the equation $\lambda = 15{,}900 - 10t$ where t is temperature centigrade. A slight discontinuity in slope of the ($\log p$, $1/T$) curve gives at the melting-point a sudden increase in the heat of vaporisation of some 600 calories, which is in good agreement with the heat of fusion by direct experiment. AUTHOR.

794. *Specific Heat Variations in Relation to the Dynamic Action of Gases and their Equations.* **W. J. Walker.** (Phil. Mag. 50. pp. 1244–1260, Dec., 1925.)—Preliminary experiments have been carried out with the object of arriving at the specific heat variations of highly superheated steam by the application of equations involving the effect of such specific heat variations on gas discharges and velocities through orifices or nozzles. The fundamental theory of this method has been given in previous papers [see Abstracts 1482 (1922) and 160 (1925)]. A new point of view is introduced into the treatment of adiabatic changes of state, resulting in the derivation of a new equation of condition for gases and vapours. The analytical investigation into the problem of incorporating the variable specific heat function (hitherto neglected in such equations) into the equation of state occupies the main portion of the paper. The resulting equation is of the Dieterici-Jeans type, the qualitative agreement of which with the behaviour of gases and vapours in general appears to be good. The equation may be written in the approximate form $V = RT/P - \alpha R(1 - 3\lambda T)/PT^2V + b$, which is similar to Callendar's equation with the term $\alpha R(1 - 3\lambda T)/PT^2V$ in place of $0{\cdot}0263(373/T)^{10/3}$, where λ is the slope of the constant pressure specific heat temperature curve at the critical point, and the other terms have their usual significance. The evidence appears to be strong that the partial disagreement of this and other earlier types of equation with the physical constants of gases and vapours is due to the absence of any term in such equations directly involving specific heat variations. T. B.

795. *Relation between the Chemical Constant and the Critical Constants for Fluid States.* **W. A. Holzschmidt.** (Zeits. f. Physik, 35. 4. pp. 304–312, 1925.)—The author examines critically the equations and results of Nernst and Cederburg and then deduces a number of facts from the van der Waals equation $\lambda/T_k = \phi(\tau)$, where λ is the molecular heat of vaporisation at the reduced temperature $\tau (= T/T_k)$, T_k is the

critical temperature and ϕ a function for all non-associated liquids. Nernst previously proved by experiment, and the author now shows theoretically, that the difference of the molecular heats of the saturated vapour and the liquid is constant for all normal liquids at the absolute zero. The chemical constant C is expressed by the formula $C = x - b/R \cdot \log T_k + \log p_k$ where x and b are universal constants. On the basis of experimental data x approximates to 6·2. The difference of the heats of saturated vapour and liquid at the absolute zero is b and approximately $b/R = 1{\cdot}75$. Values of C calculated as above and also from Nernst's relation for a number of organic compounds are tabulated, together with corresponding values for λ_s, T_s, T_k and p_k. The two sets of values for C show very good agreement. R. S. R.

796. *Compressibility of Hydrogen and Helium at Low Temperatures.* **F. P. G. A. J. van Agt** and **H. K. Onnes.** (K. Akad. Amsterdam, Proc. 28. 7. pp. 674–686, 1925. Comm. No. 176B from the Phys. Lab., Leiden.)—Continues the work of a previous paper in which the compressibility of hydrogen and helium at the boiling-point of hydrogen was investigated. In the present work the temperature range was 90° to 14° K, and the experiments were especially made to determine accurately the values for the second virial-coefficient in the empirical equation of state: $pv = A + Bd + Cd^2 + Dd^4 \ldots$ W. H. GE.

797. *Behaviour of Hydrogen according to the Law of Corresponding States.* **F. P. G. A. J. van Agt.** (K. Akad. Amsterdam, Proc. 28. 7. pp. 687–692, 1925.)—In order to see how far hydrogen deviates from the law of corresponding states the values of B_A and T given in previous communications are here converted into the reduced magnitudes and the results are discussed. W. H. GE.

798. *Effective Wave-length of Pyrometer Glasses.* **F. Henning.** (Zeits. Instrumentenk. 45. pp. 530–538, Nov., 1925.)—A theoretical treatment of the problem of determining the effective wave-length of a coloured glass for the comparison of black-body sources of given temperatures. A table is given showing the change of λ which takes place when the comparison source is at 1336° and the test source has any temperature between 800° and 3500° C. These values are given for a certain red glass (Schott. No. 4512) and a green gelatine filter. J. W. T. W.

799. *Pyrometry.* **J. L. Haughton.** (Engineer, (The Metallurgist), 140. pp. 179–181, Dec. 25, 1925.)—The calibration of thermocouples and some of the errors which can occur in using such instruments are first dealt with. Then (1) total radiation pyrometers, (2) optical pyrometers (the Wanner pyrometer and the disappearing filament pyrometer) are briefly discussed. A. A. D.

800. *A Small Resistance Thermometer.* **G. F. Taylor.** (Phys. Rev. 26. pp. 841–850, Dec., 1925.)—This thermometer, which was developed for field observations in the Department of Agriculture, fits into a sheath only about 6·4 cm. long and 0·24 cm. in diameter (and may be made even smaller). It consists of a Pb filament 1·5 cm. long and 2×10^{-3} mm. in diam. in a glass tube 4×10^{-5} mm. thick, embedded in a type metal which makes contact with one end of the filament. The method of

drawing such filaments has been previously described [see Abstract 1989 (1924)]. The resistance of the filament is 448 ohms so that with a portable galvanometer a sensitivity of 0·005° is readily obtained. The temperature lag is about 10 sec. The technique of manufacture is described. After being made, the resistance decreases about 0·06 % in the first two hours, then gradually increases about 0·05 %, reaching a constant value in about three weeks. This time effect is due chiefly to the type metal. After seasoning, the reading at 0° C. is constant to within 0·02°. Fifty of these thermometers have been in service for some time, in the range — 20° to 40° C. Thermal expansion of type metal (Pb 85, Sb 12, Sn 3).— The coefficient was found to be 0·864 times that of Pb, 0° to 100° C., or $25·23 \times 10^{-6}$ per degree. After casting, rods were observed to decrease in length 0·06 %, reaching a minimum, in 4 hours, 0·08 % less than the initial length. AUTHOR.

801. *Establishment of the Temperature Scale to — 193° by Means of Platinum Resistance Thermometers.* **A. G. Loomis** and **J. E. Walters.** (Am. Chem. Soc., J. 47. pp. 2851–2856, Dec., 1925.)—Henning has shown that the Callendar equation no longer defines a reproducible temperature below — 40°, and that temperatures calculated from the Callendar equation are more than 2° too low at liquid-air temperatures and, further, different thermometers vary by different amounts. Van Dusen has also confirmed Henning's work for platinum thermometers of the strain-free type and gives an expression involving an additional term to the Callendar equation. Townshend and Young found the deviations between the scale given by the Callendar equation below the ice point and the gas scale did not, for their instrument, follow Henning's curve. The results of the present work, which follow the lines of Henning, show that with the flat-coil calorimetric type of platinum-resistance thermometer the work of Henning and van Dusen is entirely corroborated for the strain-free type of thermometer. Henning's proposed methods of establishing the thermodynamic scale of temperature in terms of platinum-resistance thermometers, using a pure strain-free platinum filament, are shown to be both valid and reproducible. A comparative table of results is given. S. G. B.

802. *Measurement of Very Low Temperatures. XXXIII. The Comparison of the Constant Volume Hydrogen and Helium Thermometers with Various Zero-point Pressures.* **F. P. G. A. J. van Agt** and **H. K. Onnes.** (K. Akad. Amsterdam, Proc. 28. 7. pp. 693–700, 1925.)—Experiments made with the constant volume differential thermometer led to comparisons of the hydrogen and helium scales directly with each other with different zero-point pressures. The two thermometers were placed side by side at the same height in the low-temperature bath, whilst the pressures of both gases were read on the same manometer. The corrections necessary to reduce the hydrogen and helium scale temperatures for various zero-point pressures to the Avogadro scales were calculated from the data secured. It is noted that the comparisons of hydrogen and helium thermometers with various quartz reservoirs differ from those found for glass reservoirs. Tables of results are appended showing the difference in the readings between the Centigrade scales of the helium and hydrogen thermometers with different zero-point pressures. If the differences so obtained are plotted against the zero-point pressures it is

noted that for the same density the differences increase with decreasing temperature and, further, at each temperature they decrease to zero proportionately to the zero-point pressure. S. G. B.

803. *A Derivation of Saha's Equation for Temperature Ionisation.* **W. F. G. Swann.** (Frank. Inst., J. 200. pp. 591–594, Nov., 1925.)—The paper presents a simple and straightforward mathematical deduction for the derivation of Saha's equation starting with an expression for entropy derived from Planck's formula. The note is mathematical throughout. S. G. B.

804. *Absolute Value of the Entropy of Real Gases.* **V. Njegovan.** (Zeits. Elektrochem. 31. pp. 631–633, Dec., 1925.)—This investigation supplements previously published work [see Abstract 1152 (1925)], and establishes that the so-called entropy constant has in general not the characteristics of an integration constant, but is a derived function (entropy addendum) from the third law of thermodynamics, just as entropy itself in the restricted sense is derived from the second law. Both functions vanish for $T = 0$. The integration constant of the entropy equation is found to be zero for all states of aggregation and all temperatures and pressures. This conception brings the degeneration of gases into agreement with the third law. The entropy addendum is manifestly connected with the qualitative changes of the internal energy. H. H. Ho.

805. *Present Status of the Facts and Theories of Detonation.* **G. L. Clark** and **W. C. Thee.** (Indust. and Engin. Chem. 17. pp. 1219–1226, Dec., 1925.)—The authors have collected recent information bearing on the general phenomenon of detonation (in gases) with the object of submitting theories to critical examination, suggesting further experiments, and making practical applications especially to the design and operation of internal combustion engines. Different investigators have noted that the following factors are involved in combustion, explosion, and shock: (1) closed and open end tubes; (2) tube diameter; (3) tube texture; (4) tube composition; (5) change in tube diameter; (6) tube length; (7) chemical composition of fuel; (8) composition of gaseous mixture; (9) composition of secondary gas; (10) turbulence; (11) gaseous ionisation and excitation (spectroscopy); (12) method of ignition; (13) temperature of ignition; (14) compression; (15) dilution; (16) pressure. These factors are considered in turn, and various theories of detonation are criticised, *e.g.* (*a*) the dissociation theory; (*b*) Ricardo's theory; (*c*) detonation wave theory; (*d*) electron theory; (*e*) free hydrogen theory; (*f*) radiation theory; (*g*) absolute density theory; (*h*) molecular collision theory. Further researches are suggested, including the effect of tube diameter in tubes of engine cylinder dimensions; photographic experiments; turbulence; accurate spectrometric studies of combustion and detonation in an actual engine of various fuels and in the presence of various knock inducers and suppressors. A bibliography of about one hundred references to recent work is given. T. B.

SOUND.

806. *Survey of Modern Acoustic Problems.* **E. Waetzmann.** (Phys. Zeits. 26. pp. 740–748, Dec. 8, 1925. Paper read before the Deut. Physikertag., Danzig, Sept., 1925.)—Acoustics problems are discussed under three headings, *viz.*, problems in physiology, in elasticity and in hydrodynamics. The first section deals with work on threshold values, particularly recent work in America, and results are quoted for sensitiveness of the ear to loudness at different pitches as well as for sensitiveness to changes of loudness and change of pitch. The ear is most sensitive at the frequency 2000/sec., the amplitude of the air wave then necessary to excite the ear being only about the one-hundredth part of the diameter of a molecule. On an average with medium intensities a change of 10 % in intensity is detectible. The detectible change of pitch varies greatly at different pitches. At 500/sec. a change of 1½/sec. is noticeable. A curve is also given for the threshold of painfulness in hearing. As this does not differ much for deaf persons and persons of normal hearing the former cannot be made to hear simply by increasing intensity. Experiments are very desirable on the " duration threshold," *i.e.* on the minimum period during which a sound must be emitted in order to be heard. On the question of resonance in the ear, the author considers that his own and other experiments show that, contrary to Helmholtz's assumption, the sharpness of resonance increases with increasing pitch. Under the second heading is discussed the problem of difference tones, or, looked at from a more general standpoint, the problem of non-linear vibrations. An extension of previous theory is shown to be necessary. A sound wave besides setting a body in vibration can also produce in it motions of a one-sided character. The third section discusses the different known types of these as well as a new type whose existence has recently been revealed by increased sensitiveness of apparatus and whose origin is not yet explained. G. A. S.

807. *Experimental Study of Impact of Pianoforte Hammer.* **R. N. Ghosh** and **J. N. Dey.** (Indian Assoc. for Cultivation of Science, Proc. 9. 3. pp. 193–202, 1925.)—Continues the work of two previous theoretical papers by S. Bhargava and R. N. Ghosh. The duration of the impact of felt-covered hammers impinging on steel strings is measured by the photographic method. The experimental values so obtained usually agree more nearly with the theoretical values of Bhargava and Ghosh than with those of Kaufmann which refer to the unyielding hammer. The experimental and theoretical values of the maximum displacement of the struck point are also compared. The results all refer to a string struck near an end. Seven of the photographic records are reproduced. W. H. Ge.

808. *Propagation of Explosive Sounds.* **T. Vautier.** (Comptes Rendus, 181. pp. 1055–1057, Dec. 21, 1925.)—Continues the work of a previous paper [see Abstract 2421 (1924)] and deals with comparatively weak explosive sounds such as are produced by electric sparks or percussion caps of an unloaded pistol. Some further details of experimental methods are given, and it is finally concluded that the speed of waves from electric sparks is 330·56 metres per sec., and that from percussion caps is 330·58 metres per sec. The order of accuracy of the work is carefully discussed. (**Erratum**, *ibid.*, p. 1203, Dec. 28, 1915.) W. H. Ge.

ELECTRICITY AND MAGNETISM.

THEORY, ELECTROSTATICS, AND ATMOSPHERIC ELECTRICITY.

809. *Solution of the Maxwell-Lorentz Equations.* **N. v. Raschevsky.** (Zeits. f. Physik, 35. 2. pp. 100–118, 1925.)—It is here emphasised that the existence of non-radiating accelerated electron motions, as well as the emission of a monochromatic radiation by non-periodic electron motions is not opposed to the classical Maxwell-Lorentz equations themselves but to the solution of these by retarded potential. A solution of the equations is obtained which, although not absolutely analytical, has the following properties : it is finite and continuous with its first derivative, and satisfies sufficiently generally the field equations ; it vanishes at infinity ; if the motion of the electrons is periodic and stable and passes then in any way to another periodic stable state, then the field at first is radiationless, changing then continuously to a monochromatic radiation of predetermined frequency, and then again to a radiationless field. The conclusion is therefore drawn that Bohr's theory is not opposed to the classical field equations as such. [See Abstract 914 (1914).] A. W.

810. *The Structure of Light.* **J. J. Thomson.** (Phil. Mag. 50. pp. 1181–1196, Dec., 1925.)—This paper develops further the theory of light recently proposed by the author [see Abstract 177 (1925)]. The effects which on this theory would follow from collisions between quanta and electrons are discussed, when it is shown that the quanta would be deflected and lose frequency by colliding with electrons. This deflection would produce a scattering of the light made up of a great number of small deflections combined according to the theory of probability. This scattering is in addition to that which is proportional to $(1 + \cos^2 \theta)$ and accounted for by the wave theory. It is shown, too, that when the electrons are in rapid motion the theory indicates that collisions between the quanta and the electrons will produce an increase in the frequency of some of the quanta. H. H. Ho.

811. *Measurements of the Electrical Charge of the Atmosphere at Davos.* **K. Kähler** and **C. Dorno.** (Meteorolog. Zeits. 42. pp. 434–439, Nov., 1925.)—Measurements of the atmospheric electric charge were made during February and March, 1925, using a conical-shaped Faraday cage with a polonium detector connected to a Wulf thread electrometer. For undisturbed days a mean value of 0·44 E.S.U. per c.c. was obtained, with extremes of 0·64 and 0·32. Diurnal charges gave a maximum at sunrise and above all at sunset, the minimum occurring near to midday. Changes of potential gradient follow a course similar to those for electrical charge and can be deduced from them. The mean value is only two-thirds of the Potsdam value, and the daily amplitude rather less. The changes at sunset are largely due to the descent of cooled air down the mountain side, the air from these heights having a preponderance of positive charges. Only the rapid oscillations of charge and gradient do not run parallel. Fog and cloud about 50 m. high decrease the positive surface

charge and increase the gradient, and generally a relative defect of positive charge exists near the boundary of a condensation layer. Quiet snowfalls produce little change of charge or potential gradient, and the relation probably holds over large horizontal and vertical distances. Squally snowfalls may give rapidly alternating positive and negative charges. Disturbed days may produce a maximum charge of $\pm$ 2·5 E.S.U. per c.c. and a gradient exceeding 300 volts/metre. Föhn effects usually lower the potential gradient. R. S. R.

DISCHARGE AND OSCILLATIONS.

812. *Low-Voltage Arcs in Pure and Mixed Hydrogen and Nitrogen.* **C. T. Kwei.** (Phys. Rev. 26. pp. 537–560, Nov., 1925.)—The current-voltage characteristics and spectra of H_2, N_2, and mixtures of H_2 with N_2 and Hg vapour have been studied, the arc being formed in a spherical tube between an anode comprising a nickel disc and a kathode comprising a hot tungsten filament. The breaking potential in pure hydrogen shows that the ionisation potential for the molecule is 16·2 volts, after allowance has been made for the initial velocity of emission of the thermions; while a discontinuity in the current-voltage characteristic indicates an ionisation potential for the atom of 13·7 volts. In pure nitrogen the arc tends to oscillate in the neighbourhood of the ionisation potential, but investigation with an oscillograph shows that the real value of this potential is 16·9 as distinct from the apparent breaking potential of 16·2. In mixtures of hydrogen with mercury-vapour there is, for low percentages of hydrogen, a single breaking potential which is a loaded mean of the ionisation potentials of the two gases, but for higher percentages there are two striking potentials and two breaking potentials, in the sense that sudden changes in current occur as the voltage is varied. Mixtures of H_2 and N_2 behave similarly. As regards the spectra, in hydrogen the Balmer lines and secondary spectrum appear as soon as the arc is struck. In mixtures of H_2 and Hg the Hg lines ($2p - ms$) and ($2p - md$) are much intensified above the higher of the two striking potentials, while many lines of the secondary H spectrum are only present below it. With mixtures of H_2 with N_2 evidence is found that the ultra-violet band of ammonia, associated with a critical potential of 22·5 volts, is due to a molecule containing one atom of nitrogen, while the Schuster band, observed at voltages above a critical potential of 70, is emitted only in the presence of oxygen. C. W. H.

813. *Chemical Action of Quiet Discharges.* **E. Warburg.** (Zeits. techn. Physik, 6. 12. pp. 625–633, 1925. Paper read before the Deut. Physikertag., Danzig, Sept., 1925.)—After the explanation of quiet discharges this paper deals with the following points. The Siemen's tube; the separation of the conduction current from the total current; the chemical actions; the origin of the chemical action with the quiet discharge; the fraction of the electrons' shock which acts chemically; the action of atmospheric air; the dissociation of ammonia by quiet discharges and radiation. A. E. G.

814. *Electric Discharge in Gases at Low Pressures. Part III.* **R. Magini.** (N. Cimento, 2. pp. 485-510, Oct.–Nov.-Dec., 1925.)—In the previous paper [see Abstract 2333 (1925)] the author has shown that photography has enabled the functioning of empty kathodes to be much

more clearly understood. In the present paper among other points the following are dealt with: systems of three wires; other intermediate empty kathodes; rings; the cylindrical kathode; associated circular empty kathodes; the separation of the bundles in cylindrical kathodes; associated cylindrical kathodes. A. E. G.

815. *Striated Discharge in Hydrogen.* **A. Bramley.** (Phys. Rev. 26. pp. 794–799, Dec., 1925.)—Potential distribution, electron concentration and mean electron energy at eleven points were determined for a discharge through a tube 15 cm. long at pressures of 0·625, 0·20, 0·09, and 0·02 mm., using Langmuir's probe method. The total potential difference was 270–300 volts. The potential dropped to a minimum within 2 mm. of the kathode, of 125, 60 and 20 volts for pressures 0·20, 0·09 and 0·02 respectively, giving a reverse gradient in a region 1 to 2 cm. long through which the current must have been carried by diffusion of positive ions and electrons. The gradient was also reversed at the anode edge of a striation for pressures of 0·20 and 0·09 mm.; the lower pressure 0·02 mm. gave a uniform positive column. The electron concentration reached a maximum 1 to 2 cm. in front of the kathode; the values, in general, are lower the higher the pressure. The mean electron energy decreases sharply at the kathode to a minimum of 1 to 2 volts, then rises gradually to about 10 volts at the beginning of the positive column; it also reaches 10 volts at a striation. Such electrons have sufficient energy to cause the ionisation which is associated with the luminosity in the positive column. The anode drop within 2 mm. was only 5 to 15 volts, the potential distribution depending on the position of the nearest striation. AUTHOR.

816. *Absorption of Hydrogen Canal Rays in Hydrogen and Helium.* **R. Conrad.** (Zeits. f. Physik, 35. 2. pp. 73–99, 1925.)—It is here shown that the absorption of canal rays in passing through hydrogen and helium at a pressure of 0·05 mm. of mercury and for velocities of the order of 2×10^8 cm./sec. is principally due to scattering. An approximate treatment based on the elementary scattering formula is given which allows the final angle of the canal ray beam to be estimated. It was established experimentally that the coefficient of scattering for hydrogen canal rays in hydrogen and helium is directly proportional to the gas-pressure and inversely proportional to the fourth power of the velocity of the rays at a pressure of 0·02 mm. of mercury. A. W.

817. *The Ionisation of Nitrogen by Electron Impact as interpreted by Positive Ray Analysis.* **T. R. Hogness** and **E. G. Lunn.** (Phys. Rev. 26. pp. 786–793, Dec., 1925.)—Using an apparatus previously described in which ions formed by impact of electrons of energy $(V_1 + V_2)$, or by secondary processes, are pulled from the ionisation chamber by the field V_3 and then analysed magnetically by Dempster's method [see Abstract 788 (1918)], the relative numbers of ions of type N_1^+ and N_2^+ are measured for various pressures and voltages. At low pressures (less than 10^{-5} mm.) only N_2^+ was observed; as the pressure was increased the percentage of N_1^+ increased regularly and reached 60 at 0·006 mm. The percentage of N_1^+ was markedly greater when helium at a relatively high partial pressure was present. Below 24 volts, no N_1^+ ions were produced, although N_2^+ ions appeared with $(V_1 + V_2)$ greater than

17 volts. These N_2^+ ions must therefore be stable toward collisions, while above 24 volts N_2^+ ions are produced which may be disrupted on collision to form N_1^+ ions. The critical potentials for nitrogen of 16·95 and 24·6, then, correspond to the formation of N_2^+ (stable) and N_2^+ (unstable). N_1^+ ions are therefore produced only by dissociation of unstable N_2^+ ions. The percentage of N_1^+ was found to be independent of the field V_3 from 2·7 to 27 volts, hence the dissociation of an unstable N_2^+ ion is independent of its speed over this range. N_1^{++} ions are not produced at all below 500 volts. The N_2^- ions found by Smyth were present but too weak to be studied. A diagrammatic representation of the electrons distributed in the two types of N_2^+ ion is suggested in accordance with the ideas of G. N. Lewis. Correlation with spectroscopic evidence indicates that the negative bands are emitted by the stable ions. AUTHORS.

818. *The Secondary Emission from a Nickel Surface due to Slow Positive Ion Bombardment.* **A. L. Klein.** (Phys. Rev. 26. pp. 800–806, Dec., 1925.)—The apparatus was arranged so that positive ions from a heated Mo strip coated with aluminium phosphate were accelerated radially through slots in shields A and B, and a wider slot in an electrode C to the target T, from which the secondary emission to the electrode C was measured. The parts A, B, C and T were all concentric nickel cylinders, symmetrically placed about the emitter. If the potential of the emitter is made zero and the accelerating potential V_1, when the collector is at zero potential only reflected positives are collected. As the potential is increased, secondaries also reach it, the net negative charge increasing until a saturating potential $2V_1$ is reached, when all negatives and no positives are collected. The percentage saturated secondary electron emission was found to increase approximately as the square of the primary ion energy, reaching 22 % of the primary ion current, for primary ions of energies corresponding to 380 volts. The curves show that large numbers of reflected positive ions have energies between zero and 2 volts, and there is also a group of reflected positive ions with energies approximately 0·9 of the primary energy. AUTHOR.

819. *The Mobility of Negative Ions in Gasoline, Hydrogen, and Hydrogen-Chlorine Flames.* **P. E. Boucher.** (Phys. Rev. 26. pp. 807–819, Dec., 1925.)—The Hall effect method of measuring the mobility of the negative ions was used, the horizontal or vertical flame being placed in a field of 4000 to 5000 gauss. The Pt kathode was coated with sealing wax. The temperature was varied by control of the air or oxygen intake and was measured, relatively, by a Pt-PtRh couple. In a hydrogen flame the mobility increases with temperature somewhat for potential gradients over 25 volts/cm., but in a gasoline vapour flame the mobility decreases markedly. The addition of Cl, Br, $CHCl_3$, CCl_4, NH_4Cl or I (in alcohol) to the hydrogen and gasoline flame decreases the mobility, the effect being greatest for Cl and being progressively less for the other substances in the order given. In the hydrogen-chlorine flame values as low as 52 cm./sec. per volt/cm. were obtained. Addition of NaCl, Na_2CO_3 or KCl increases the mobility somewhat. The highest value obtained is 5600 for hydrogen flame with NaCl sprayed in, about 30 % higher than for a similarly sprayed gasoline flame. In explanation of these variations it is suggested that when certain substances, particularly the halogens,

are added to the flame, the negative ion which is normally a free electron for the greater part of its life, tends to be attached to form a cluster so that the average period during which it is a free electron is decreased and hence the mobility also. Temperature changes and potential changes probably affect the mobility by influencing the formation of these clusters. AUTHOR.

820. *Secondary Magnet Canal Rays.* **E. Goldstein.** (Zeits. f. Physik, 34. 11–12. pp. 893–897, 1925.)—In that part of the tube which the positive glow-light streams through, an electromagnet at the narrowing of the lumen on the anode side produces secondary canal rays originating here. This takes place in quite pure elementary gases. The bundle of rays shows under suitable conditions a very great aperture. In it projected shadows remain rectilinear even when the bundle is bent through a great angle by altered field direction. As a matter of fact, only the intensity in the unbent remaining rays shifts. A. E. G.

821. *Kathodic Pulverisation of Alloys.* **J. Mazur.** (Acad. Polonaise Sci. et Lettres, Bull. No. 3–4a. pp. 81–92, March–April, 1925. In French.) —It is here shown that two metals which do not blend in the solid state are differentiated in kathodic pulverisation, and an examination of the surface by the microscope enables the constituents to be distinguished. In alloys in which there are chemical compounds these act as distinct constituents. The comparison of results of metallographic examinations of pulverised alloys and of alloys which have been treated chemically makes it clear that the method of pulverisation is sufficient for determining the structure of the alloy. Upon the surface of pure metal plates submitted to kathodic pulverisation there can be seen the elements of a structure due to slight heterogeneities in the mass of the metal, to different orientations of the crystals, to the existences of cellules of crystallisation, to traces of impurities, etc. The deposits obtained by pulverisation have a different composition from that of the layer pulverised. For alloys of metals which do not blend in the solid state the ratio of the constituents is equal to the ratio of the surfaces occupied by them in the layer pulverised. Observations on the position of the points of formation of the deposits, of the form of the deposits behind obstacles and the direction in which the vapours spread, show that the metal is not transported by the force of the electric field. A. E. G.

822. *Loss of Velocity of Kathode-Rays in Metal Foil.* **E. Warburg.** (Zeits. f. Physik, 35. 3. pp. 177–178, 1925.)—The results obtained many years ago by Lenard, Leithäuser and others are discussed with reference to the recent work on this subject by Klemperer [Abstract 360 (1926)]. It is shown that Klemperer's results completely confirm certain results obtained by Leithäuser [Abstract 158 (1905)]. A. W.

823. *Emission Work and Contact Potential.* **H. Rothe.** (Zeits. techn. Physik, 6. 12. pp. 633–638, 1925. Paper read before the Deut. Physikertag., Danzig, Sept., 1925.)—In this paper is given a simple method for the exact measurement of contact potentials between glowing bodies in a vacuum. It is shown that in three electrode tubes with oxide kathodes there can be a considerable contact potential between the electrodes, which may explain the deviations which appear with these tubes as compared with tubes with metal kathodes. Since there exists

a contact potential between hot and cold platinum, it follows that the emission work and electron concentration of a body alters with the temperature. A. E. G.

824. *On the Nature of the Ions from Hot Platinum.* **H. A. Erikson.** (Phys. Rev. 26. pp. 625–628, Nov., 1925.)—The mobilities of the ions produced by hot platinum were obtained by driving the ions across a stream of air by means of an electric field. The currents at a downstream point were obtained at different values of the field. The current voltage curves for the ions from platinum were compared with curves obtained in a similar manner using ions produced in air by alpha-rays. An initial and a final positive ion and one negative ion were found, the same as in the case of the air ions. The mobility values obtained for these ions are also the same as for the air ions. A discussion of the results leads to the conclusion that the negative and final positive ions from platinum are air ions. The initial positive ion may also be an air ion, but this is less certain. AUTHOR.

825. *Variation in the Photoelectric Emission from Platinum.* **A. E. Woodruff.** (Phys. Rev. 26. pp. 655–670, Nov., 1925.)—The specimens of platinum were ribbons 3 cm. long by 5 mm. wide and 0·013 mm. thick, mounted on a pyrex tube with a quartz window. The effect of heat treatment was first studied, the rate of recovery of a specimen after heating depending on the wave-length, pressure and previous treatment. Thermionic measurements were also made, giving results in general agreement with theory. It was shown also that after prolonged heating at 10^{-6} mm. pressure small electric potentials, 0·01 to 0·06 volt, are sufficient to prevent the escape of all electrons excited by mercury-arc radiation. The results seem to require an adsorbed layer of gas for their explanation. A number of observations were also made with an iron arc. A. B. W.

826. *Scattering of Electrons in Ionised Gases.* **I. Langmuir.** (Phys. Rev. 26. pp. 585–613, Nov., 1925.)—Analysis of the current received by a collector placed opposite a hot kathode indicate three groups of electrons: (1) Primary electrons, which retain nearly all the momentum they acquired in passing through the positive ion sheath around the kathode; (2) secondary electrons, moving in random directions with a Maxwellian velocity distribution corresponding to a temperature roughly proportional to the energy of the primaries and approximately independent of the nature or pressure of the gas or the current density; (3) ultimate electrons, having a Maxwellian velocity distribution corresponding to a much lower temperature than that of the secondaries—a temperature which is independent of the current density or the voltage of the primary electrons, and which varies with the gas used and decreases slowly as the pressure is raised. In the uniform positive column of arcs only ultimate electrons are present. Experiments with two crossed electron beams prove that the secondary and ultimate electrons, directly or indirectly, are responsible for very little of the scattering. A study of the ultimate electrons in the positive column of a low-voltage Hg arc shows that the Maxwellian velocity distribution corresponding to a high temperature is maintained. After analysing the effects to be expected when a beam of primary electrons encounters a cloud of stationary electrons, or a cloud of particles of small mass but of high temperature,

it appears that the experimental results for the ratio of the scattering to the average retardation of the beam is best accounted for by collisions with a cloud of radiation quanta, a kind of Compton-effect. The observed scattering is, however, about 10^{16} times greater than a normal Compton-effect would give. It is suggested that the joint action of excited atoms and radiation may multiply the Compton-effect sufficiently, or it may be that the presence of a free electron with a distance of a wave-length from an excited atom may greatly increase the probability of a quantum jump and that momentum is delivered to the electron in the process. Other experiments seem to indicate that electron scattering similar to that observed in low-pressure gases can also occur in a high vacuum.

A. E. G.

827. *Relative Production of Negative and Positive Ions by Electron Collisions.* **F. L. Mohler.** (Phys. Rev. 26. pp. 614–624, Nov., 1925.)—In the tube used either positive or negative ions produced by an axial beam of electrons accelerated from a filament by a voltage V are collected on a concentric cylindrical electrode D by maintaining it at a potential slightly lower or higher than that of the beam, the primary electrons being prevented from reaching D by means of a solenoidal magnetic field of 100 gauss parallel to the axis. While saturation is not always reached, the relative values of the positive and negative ion currents are significant. Contrary to the ordinary theory, the polar compounds, mercuric chloride and hydrogen chloride, give results quite similar to those for the elements mercury and iodine. With electron currents of the order of 10^{-6} amps. and pressures of about 0·001 mm., the negative ion current is in all cases small compared with the positive ion current above the ionisation potential. With larger currents the negative current increases sharply at the ionisation potential and the ratio to positive current is greater. For vapours other than mercury there are some negative ions produced at all voltages, the negative ion currents each having a maximum at zero and increasing again at certain critical potentials, the voltages being 4 for $HgCl_2$, 6·5 for HCl, and 2·4, 4·6, 8·4 for I_2. As far as is known, these potentials are equal to potentials of inelastic collision. These experiments give no support to the theory that electron collisions dissociate polar molecules into positive and negative ions. In agreement with the results of the magnetic analysis of positive ions, they indicate that the primary effect of an electron impact is the production of a positive molecule ion. The negative ion curves obtained can be explained by the hypothesis that only slow-moving electrons attach themselves to molecules to form ions, but the absence of low-voltage negative ions in the case of Hg is not understood. A. E. G.

828. *Evidence for Electron-Atom Collisions of the Second Kind.* **H. D. Smyth.** (Nat. Acad. Sci., Proc. 11. pp. 679–682, Nov., 1925.)—Two cases are considered, the collision of negative iodine ions with electrons and the decomposition of ozone. In the first case, a lime-coated source of electrons, a grid and collecting electrode are mounted in a pyrex tube in a furnace. The tube contains iodine vapour. An accelerating field is applied between the source and the grid, and a retarding field between the grid and the collecting electrode. If any electrons reach the collecting electrode when the retarding field is greater than the accelerating field, the extra energy must be that of a negative iodine ion (3·5 volts) given

up to an electron in a collision of the second kind. Plotting the current against the retarding voltage gives evidence of two groups of electrons having velocities greater than the main group, but further results are needed to substantiate the existence of the effect. A similar effect, but of very small magnitude, is noted when ozone is present in the tube. In this case the theory is complicated by the fact that ozone has three modes of decomposition corresponding to different critical increments. Further investigations are intended. A. Wh.

829. *Motion of Electrons in Gases.* **J. S. Townsend.** (Frank. Inst., J. 200. pp. 563–590, Nov., 1925.)—This paper, which gives a general survey of the progress made in research upon the motion of electrons in gases up to 1924, is well illustrated by tables of results and numerous graphs. A. E. G.

830. *Gas Atoms in Contrast with Slow Electrons.* **M. Rusch.** (Phys. Zeits. 26. pp. 748–751; Disc., 751, Dec. 8, 1925. Paper read before the Deut. Physikertag., Danzig, Sept., 1925.)—The behaviour of the gas atom in contrast with slow electrons appears suitable to give an explanation on the atomic field of force. In this paper the question is treated from the experimental standpoint by extending the cross-section action measurements to smaller electron velocities (2 to 0·2 volts). The results obtained show that the cross-section action functions of argon and krypton have a minimum at 0·7 to 1·1 volts; those of neon and hydrogen show a decline to some tenths of a volt with decreasing velocity. [See also Abstract 1947 (1925).] A. E. G.

831. *Diffusion of Slow Electrons in the Electric Field.* **G. Hertz.** (Phys. Zeits. 26. pp. 868–869; Disc., 870, Dec. 23, 1925. Paper read before the Deut. Physikertag., Danzig, Sept., 1925.)—The author has recently shown [see Abstract 2139 (1925)] that the motion of slow electrons in an electric field in a gas, at whose molecules they are reflected with vanishing loss of energy, must be considered as a diffusion process. If v = the velocity of the electrons, λ their mean free path, Q their density (therefore the number of electrons in unit volume), and γ the acceleration which an electron experiences in the electric field in the direction of the positive X-axis, then the number of electrons N, which in unit time pass through the unit of surface in the direction of the X-axis in excess of those travelling in the reverse direction, is given by $N = vd\lambda Q/3dx + Q\gamma\lambda/3v$. From this it is assumed that the increase of energy which an electron experiences in an electric field by passing through a free path is small compared with the energy of the electron. In the present paper an attempt is made to prove the results of these theoretical considerations in a simple case. A. E. G.

832. *On the Vaporisation of Electrons.* **W. Schottky.** (Zeits. f. Physik, 34. 9. pp. 645–675, 1925.)—An attempt to place the theoretical determination of the formulæ for the vapour-pressure and emission of electrons on a more general basis than that employed by v. Raschevsky. For this purpose the Gibbs thermodynamic potential μ of electrons in metal is utilised, and by tracing the course of the temperature of μ it is demonstrated that it is not the specific heat of the electrons in the metal, but the alteration in the specific heat of the metal on the emission of electrons which, together with the rise in potential on the surface of

the metal, is the determining factor in the course of the temperature of the vapour-pressure. This alteration in the specific heat is, further, brought into relation with the Thomson-effect and the thermal effect in the temperature gradient of the conductor, and a presumably new expression found for this thermal effect. The independent variables of the problem are discussed and statistics of metallic electrons on a new basis foreshadowed. In the course of the treatise, which is entirely mathematical, reference is made to, among others, Fowler [Abstract 1484 (1923)]; Dushman [Abstract 310 (1924)]; Richardson [Abstract 1869 (1924)]; Wilson [Abstract 2315 (1924)]; v. Raschevsky [Abstracts 2343, 2578, 2579 (1925)]. E. F.

833. *Influence of Residual Gas on the Oscillations of Short-wave Electron-Tube Generators.* **M. T. Grechowa.** (Zeits. f. Physik, 35. 1. pp. 59–69, 1925.)—In the previously described short-wave generator a certain definite pressure is maintained in the tubes and is measured by the method of Kaufmann and Serowy. The dependence of the wave-length and intensity of the oscillations on the pressure of the residual gas is investigated. It is found that those quantities in the pressure region $5 \cdot 10^{-8}$ mm. Hg to $1 \cdot 10^{-4}$ mm. Hg are independent of the pressure. At higher pressures the oscillations disappear at about $1 \cdot 10^{-3}$ mm. Hg. A new arrangement is here described which is more convenient than that previously given and seems to enable shorter waves to be generated.

A. E. G.

834. *Short-Wave Oscillations.* **N. Kapzov.** (Zeits. f. Physik, 35. 2. pp. 129–154, 1925.)—An investigation was made of short-wave electric oscillations obtained with the arrangement employed by Barkhausen and Kurz [Abstract 908 (1920)], and also Gill and Morell [Abstract 1471 (1925)], in which mercury-vapour is used in an electron tube. Special tubes were constructed with different anode and grid diameters, and control experiments were carried out with the evacuating pump connected, liquid air being used for cooling. The lowest grid potential at which oscillations are generated in mercury-vapour in such tubes corresponds to the beginning of the steep part of the anode current-grid volts characteristic. Increasing the grid potential reduces the intensity of the oscillations. The minimum anode current occurs at a second hump of the characteristic, the wave-length of the corresponding oscillations being then only about half that of the oscillations at the first hump. The wave-length of the oscillations appears to be nearly independent of the pressure of the mercury-vapour. With increasing pressure λ first increases slightly and then decreases. With increased filament current and grid potential the wave-length decreases, and it depends also on other factors. With certain tubes smaller wave-lengths were obtained than are given by Scheibe's formula. The observed phenomena can be qualitatively explained by means of the theory of Barkhausen, Kurz and Scheibe with respect to the positive and negative space charges. A. W.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

835. *Effect of Tension on the Resistance of Metals.* **P. W. Bridgman.** (Am. Acad., Proc. 60. pp. 423–449, Oct., 1925.)—The resistance in a conductor under stress is anisotropic, and the paper investigates experimentally and theoretically the relation between the longitudinal coefficient

of resistance (for current flow parallel to mechanical tension) and the transverse coefficient (for current flow at right angles to the tension). The geometric mean of these coefficients is found by passing current into and out of a rectangular strip at two contact points and measuring the potential difference between two further contact points located between the former pair, the four points being in a straight line and arranged either parallel or perpendicular to the tension. The longitudinal coefficient is found by passing current into and out of the ends of a long narrow strip and measuring the potential difference between two points near the middle; and the transverse coefficient is deduced from the above results. Reliable results are obtained for Pd, Pt and Fe, the transverse coefficients being positive in these cases. The two coefficients for Ni are opposite in sign and otherwise abnormal, and vary with the history of the specimen, while the results for metals with low elastic limits are uncertain. It is deduced from the observations that a theory of resistance depending on the free paths of the electrons in the metal ought to allow for a tendency of the electrons to move along guided paths. In addition to experimental details, the paper gives a mathematical analysis in which the equations for current flow in an infinite anisotropic sheet are deduced from those for an isotropic sheet. The case of a finite rectangular sheet is then dealt with by means of a method of images, wherein the infinite plane is divided up into rectangles of the required size, each containing a current source and sink. The effective resistance between two points in an infinite plane is $(1/\pi k_1 k_2) \log \{(\beta + \alpha)/(\beta - \alpha)\}$, where k_1, k_2 are the longitudinal and transverse conductivities, 2β is the distance between source and sink, and 2α is the distance between the two points. The correction for finiteness may amount to 12 %. A relation is also deduced between Young's modulus, Poisson's ratio and the resistance coefficients, which enables a comparison to be made between results obtained with longitudinal, transverse and hydrostatic strain. The agreement is fairly good in the cases of Pt, Pd and Fe. C. W. H.

836. *A Mathematical Treatment of the Electric Conductivity and Capacity of Disperse Systems. II. The Capacity of a Suspension of Conducting Spheroids surrounded by a Non-conducting Membrane for a Current of Low Frequency.* **H. Fricke.** (Phys. Rev. 26. pp. 678–681, Nov., 1925.)—The following formula for the specific capacity C of the suspension—*i.e.* the parallel capacity of a 1 cm. cube of the suspension—is derived in terms of the capacity C_0 of 1 cm.^{2} of the membrane surrounding the spheroids, the major axis $2q$ of a spheroid, the specific resistances r and r_1 of suspension and suspending phase, and a constant α which depends only on the axis ratio a/b of the spheroid: $C = C_0 \alpha q (1 - r_1/r)$. The values of α are given in a table. One application of the formula is the determination of the thickness of interphasial membranes (biological, adsorptive, chemical). The formula can also be used for a suspension of polarisable homogeneous spheroids when the polarisation resistance is small compared to the impedance of the polarisation capacity. [For Part I see Abstract 651 (1925).] AUTHOR.

837. *The Electric Capacity of Suspensions of Red Corpuscles of a Dog.* **H. Fricke.** (Phys. Rev. 26. pp. 682–687, Nov., 1925.)—Measurements were made with a bridge, using a substitution method whereby the suspension is indirectly compared with a diluted serum which has the same

specific resistance as the suspension. The bridge may be used with frequencies ranging from 800 to 4,500,000 cycles and its sensitivity is such that a capacity in parallel to 100 ohms can be measured with an accuracy of a few $\mu\mu$f at the lowest frequency. Measurements with a frequency of 87,000 cycles per sec. were made of suspensions of red corpuscles of a dog with volume concentrations between 10 and 88 %, confirming the formula $C(\rho) = C_{100}(1 - r_1/r)$ previously derived. By these measurements and the previous formula $C_0 = C_{100}/\alpha q$ the capacity per cm.^{2} of surface of a red corpuscle is calculated to be $0{\cdot}81\mu$f. This capacity is independent of frequencies between 3600 and 4,500,000 cycles and is also independent of the suspending liquid. It is probably the static capacity of the membrane which surrounds the corpuscle. According to this assumption and using 3 for the dielectric constant, the thickness of the membrane is $3{\cdot}3 \times 10^{-7}$ cm. (monomolecular). AUTHOR.

838. *Influence of Strain on Thomson-Effect.* **H. E. Smith.** (Phys. Soc., Proc. 38. pp. 1–8; Disc., 8–9, Dec., 1925.)—Nettleton's method has been used to study the influence of tension on the Thomson-effect in wires. For pianoforte steel, charcoal iron, constantan and nickel, the Thomson coefficient numerically decreases with tension until the elastic limit is reached, after which it increases. With removal and restoration of tension a new definite cycle is followed. The Thomson-effect in tungsten, here measured for the first time, increases with tension and also follows a cycle. No change in the Thomson-effect is noticed in brass or German silver. Heterogeneity was not present in the specimens investigated. The results are clearly summarised in five graphs and the experimental details include particulars of an arrangement for obtaining a steady current from the mains. W. H. GE.

839. *Electrical and Photoelectric Properties of Thin Films of Rubidium on Glass.* **H. E. Ives** and **A. L. Johnsrud.** (Astrophys. J. 62. pp. 309–319, Dec., 1925.)—Films which spontaneously deposit on glass surfaces in a highly exhausted cell containing rubidium are electrically conducting, and photoelectrically active. A study of the photoelectric properties of a rubidium coated plane glass surface shows the normal and selective effects less well differentiated than for the similar coatings which form on metal plates. A rubidium film formed on the inside of a glass cylinder is found to exhibit, in the dark, a pure ohmic resistance. This decreases under illumination in a manner which appears to be explained as due to the liberation of photoelectrons which under a potential gradient form an added current along the tube. AUTHORS.

840. *The Photoelectric Threshold for Mercury.* **C. B. Kazda.** (Phys. Rev. 26. pp. 643–654, Nov., 1925.)—In order to ensure a perfectly clean surface of mercury for test, the apparatus was arranged so that carefully purified mercury flowed intermittently into a shallow iron cup and out through an overflow opening at the surface back into an electrically heated still. Direct observation showed that with such a flow the surface cleans itself of any added contamination very quickly. Also, the results for the wave-length limit were found to be independent of the rate of flow, to a rate far below that normally used, and also unaffected by the presence of gases (air, H_2, O_2, He and CO_2) and even of traces of water vapour in the photo-chamber. The photo-currents to a copper oxide receiver were measured by means of a quadrant electrometer to within

about 1 % for various Hg lines from a Cooper-Hewitt quartz mercury arc, correction being made for stray light by means of intermediate readings. This arc operated at 92 to 93 volts with 2·1 amp., was constant to 1 %. Intensity measurements accurate to 1 % were made by means of a vacuum thermopile connected to a d'Arsonval galvanometer (sensitivity 10^{-9} amps.) using a Hilger monochromator to disperse the light and making correction for stray light by taking readings between the lines. Plots of the ratio of corrected photo-current to corrected light intensity as a function of wave-length give the threshold at 2735 Å. The corresponding photoelectric work function is 4·52 volts. This result is free from the objections raised to those of previous observers, and seems clearly to be the evaluation of an intrinsic property of mercury uncontaminated by surface impurities. AUTHOR.

841. *Photoelectric Conduction in Selenium.* **B. Gudden** and **R. Pohl.** (Zeits. f. Physik, 35. 4. pp. 243–259, 1925.)—Although according to the literature of the subject certain kinds of selenium are not photoelectrically conducting, yet the distinctive phenomena of the photoelectric primary current are here demonstrated for one such selenium modification. In red insulating selenium the photoelectric current is observed to have a finite initial value which is proportional to the light energy, these facts being as well established in this case as for diamond, etc. The spectrum distribution of the light action shows the characteristic maximum at the optical absorption edge at about 0·7 $\mu\mu$. By irradiation with photoelectrically active (" exciting ") light the absorption spectrum is extended towards longer waves. The displacement of electrons (in an electric field the positive part of the primary current) takes place most often within a few seconds by thermal movement, but also by absorption of such long wave light whose absorption has first been called forth by the " excitement." In both cases the displacement of the electrons leads back to the original absorption spectrum. The change of the photoelectric current with time and the attainment of a stationary state resembles to a great extent that observed with coloured sodium chloride at a high temperature. Accordingly the mechanism of conductivity really seems to accord in essential characteristics in both crystal groups with photoelectric conductivity (for natural and foreign colouring). Allusion is made to the wide application of one of the two essential foundations of crystal phosphorescence. Previous measurements on metallic and technical selenium are arranged and their photoelectric significance deduced. It is shown by some examples that the observations are accompanied by very complicated secondary current phenomena. G. A. S.

842. *Investigation of Photoelectric Valve coated with Potassium.* **V. M. Albers.** (Phys. Rev. 26. pp. 671–677, Nov., 1925.)—Study of dumb-bell valve coated with potassium.—The tube used by Tykocyner and Kunz [see Abstract 1917 (1924)] has been studied more thoroughly. In the case of a transparent deposit on the connecting tube, curves are given showing the current through the tube when illuminated I_l, and when dark I_d. The ratio I_l/I_d reached a minimum at 40 and at 300 volts. The difference reached a maximum for a potential difference of 200 volts. The current increased linearly with light intensity at first and then less rapidly, approaching a saturation value. With an opaque film of potassium, illuminated through a window, the current increased in

proportion to the voltage to 1000 volts and also in proportion to the light intensity. Evidently the thicker film gave the more efficient valve. Tests with dispersed light showed that with both transparent and opaque films, the current per unit energy decreased rapidly with increasing wave-length, reaching zero at between 520 and 540 $m\mu$. In explanation of these effects it is suggested that photoelectric emission from the film reduces the accumulation of electrons on the wall which tends to stop the current through the tube by electrostatic repulsion. However, this does not explain the variation of the effect with wave-length. AUTHOR.

843. *Dielectric Constant of Weak Electrolytes.* **T. Nayder.** (Acad. Polonaise Sci. et Lettres, Bull. No. 7a. pp. 247–258, July, 1925.)—Measurements of the dielectric constants of benzoic acid, salicylic acid and picric acid, dissolved in benzene and nitrobenzene, were made. The method of measurement was a resonance method developed by M. Gizewski. The results obtained show that the dielectric constant of solutions in nitrobenzene are always less than that of the pure solvent, just as in the case of aqueous solutions. F. J. B.

844. *Rectification at Contacts between Partial Conductors and Metals.* **A. Ball** and **E. Ball.** (Zeits. f. Physik, 35. 3. pp. 207–212, 1925.)—The research here described is a continuation of previous work by Kramer [Abstract 3026 (1924)]. The effect of temperature, pressure and other factors on the rectification at contacts between partial conductors and metals was investigated for several contacts. It was found that the structure of the contact surfaces plays a very important part in contact rectification. A. W.

845. *A Thin Graphite-Tube Electric Vacuum Furnace.* **J. R. Partington** and **W. L. Anfilogoff.** (Faraday Soc., Trans. 21. pp. 360–370; Disc., 371–373, Dec., 1925. Engineering, 121. pp. 42–43, Jan. 8, 1926. Abstract.)—An improved graphite-tube furnace retaining the characteristics of the Ruff furnace [see Abstract 345 (1915)] has been constructed. The furnace is mounted vertically, and the chief materials used are graphite and bronze. The hot tube in which the graphite crucible is suspended is surrounded by the radiator case which is enclosed by the furnace casing made of bronze; the casing is lined inside with fireclay. Outside the casing is the water-jacket contained in a zinc cylinder. The whole is mounted on a base through which the lower fittings of the hot tube protrude. Connection with the air pump is made through the copper tube and the current is taken to and from the bronze leads. The main body, *i.e.* the water-jacket, measures approximately 13 in. in diameter and 19 in. in height. The hot tube, 17 in. long and $1\frac{1}{2}$ in. in diameter internally, is of a peculiar shape. The graphite, near the ends which taper, has a wall thickness of $\frac{3}{16}$ in. In the central portion, 6 in. long, the wall thickness is reduced to about $\frac{1}{16}$ in. The object is to concentrate the heat in the central portion of the tube, while keeping the ends sufficiently thick to carry the current without becoming hot. The central portion of the hot tube is generally provided with a series of slits, arranged on a helix. When not perforated in this way, at least one $\frac{1}{16}$ in. hole is drilled through the shoulder of the tube to equalise any pressure differences inside and outside the tube. The ends of the hot tube fit into graphite adapters. The two adapters are not quite identical, the upper adapter being recessed in order to fit the upper furnace seal. The hot tube and

its adapters are supported by a spiral spring of bronze, the size and strength of which are of paramount importance. Too strong a spring would make the hot tube collapse under excessive longitudinal pressure, while if too weak the spring would itself get hot, and arcing might occur at the top adapter and seal of the tube. The spring selected is of hard-drawn brass wire, $\frac{5}{32}$ in. in diameter, giving a compression of $\frac{3}{16}$ in. per lb. weight. The water jacket is a zinc cylinder soldered at the seam and to the base plate of steel. In working, the temperature is allowed to rise to 90° F. in the main jacket, and to 110° or 120° in the upper jacket. The insulation is effected by means of vulcanite bushes and rubber, jointing of the latter material being also inserted between the cover and casing. The furnace, up till now, has been used chiefly for the study of carbides and gas reactions. Temperatures of 2000° C. have been maintained for eight hours; at 2500° C. the thin hot tubes lasted for three-quarters of an hour. The purer the graphite the longer it will last. J. B. C. K.

846. *Ballistic Electrometer.* **S. Timpanaro.** (N. Cimento, 2. pp. 511–515, Oct.-Nov.-Dec., 1925.)—In 1906 Jacoviello carried out a series of experiments with the ballistic electrometer (see Abstract 473 (1907). With a modified form of apparatus, of which illustrations are given, the author finds that Jacoviello's observations are in the main confirmed. E. F.

847. *Varying the Sensitivity of Galvanometers.* **F. Wenner.** (Optical Soc. America, J. and Rev. Sci. Inst. 11. pp. 495–504, Nov., 1925.)—When the quantity being measured is proportional to an electromotive force rather than to a current, the sensitivity may be reduced either by putting a resistance into the circuit in series or (since the galvanometer and source of e.m.f. both have resistance) in parallel with the galvanometer. If a series resistance is used the resistance of the circuit to an electromotive force developed within the galvanometer is increased, while if a parallel resistance is used this resistance is decreased. By the use of two series resistances and a parallel resistance the resistance of the circuit may be kept constant while the sensitivity is reduced as much as may be desired. The parallel resistance may be connected directly across the galvanometer or across the galvanometer and the series resistance. For the former arrangement $S = (n - 1)X$ and $P = nX/(n - 1)$ and for the latter arrangement $T = (n - 1)X/n$ and $P = X/(n - 1)$, where X is the resistance of the source of the electromotive force, S the series resistance, n the ratio of the normal sensitivity desired, P the parallel resistance, and T the series resistance. T. C. H.

848. *Design and Use of an Air-Condenser for High Voltages.* **E. H. Rayner.** (Journ. Sci. Instruments, 3. pp. 33–38, Nov.; 70–77, Dec., 1925, and pp. 104–106, Jan., 1926.)—An air-condenser for high voltages is a valuable instrument for measurements in which small errors of phase angle are of importance. Such errors are commonly present in high resistances which are frequently used in high-voltage measurements, by reason of capacity currents between parts of the resistance and surrounding objects. They may amount to many minutes of phase angle. An air-condenser can be made "pure," *i.e.* free from errors associated with stray capacity, resistance or inductance, much more easily than a resistance can be made "pure," *i.e.* free from inductance or capacity effects. One of the uses of an air-condenser is to form a standard of perfection when

testing insulating materials, in which the phase angle to be measured is only a few minutes. The design and construction of a condenser suitable for about 30 kilovolts is described, and a comparison is given of the results of measurements made at 20 kilovolts on insulating material having a power factor of less than 1 %, with the results of measurements made with an electrostatic wattmeter, the power involved being a little more than a tenth of a watt. The results show a satisfactory measure of agreement. AUTHOR.

849. *Measuring the Capacity and High-frequency Loss of a Condenser.* **L. A. Sayce.** (Journ. Sci. Instruments, 3. pp. 116–117, Jan., 1926.)—The paper is an extension of a recently described method [see Abstract 1477 (1925)] for the precise measurement of the capacities of small condensers, and shows a simple way of measuring their high-frequency losses. AUTHOR.

850. *Kathode-Ray Oscillograph.* **W. Rogowski** and **E. Flegler.** (Archiv f. Elektrot. 15. pp. 297–303, Dec. 5, 1925.)—In a previous paper [Abstract 2143 (1925)] oscillograms were reproduced of surges along a conductor. The present paper describes the oscillograph employed in the above investigation. A detailed description, with photographs, is given of the arrangements used (*a*) for plates, (*b*) for films within the vacuum chamber. The plate-holder only provides for a single plate, but the film-holder allows many photographs to be obtained on the strip of film without removal from the vacuum chamber. Electromagnetic arrangements are used for bringing the plate or film into position. A diagram is given showing how the oscillograph was connected up in the research previously described. A. W.

851. *Kathode-Ray Oscillograph.* **W. Rogowski** and **W. Grösser.** (Archiv f. Elektrot. 15. pp. 377–384, Dec. 5, 1925.)—A new oscillograph of the Braun type is described which gives a very intense spot of light on the fluorescent screen, so that with an F 4·5 camera lens damped oscillations of the order of 200,000 periods per sec. can be photographed. Research with oscillographs of the Samson and Engelhardt types led to the design of a special form of kathode with auxiliary electrode. The anode is situated about 10–12 mm. away from the kathode, and is pierced with a central hole, a long metal tube projecting behind it to screen the rays from disturbing effects due to charges on the glass walls of the tube. Near the further end of this tube a coil is fitted outside and concentric with the envelope. This serves to concentrate the kathode beam, thus giving a more intense fluorescent spot on the screen. Photographs are reproduced of damped discharges with frequencies of 100,000 periods per sec. A. W.

852. *Modification of Alternate-Current Analyser.* **J. Stock.** (Acad. Polonaise, Sci. et Lettres, Bull. No. 1–2a. pp. 11–19, Jan.–Feb., 1925. In German.)—A description is given of an arrangement whereby it is made possible to examine on a phosphorescent screen, or to photograph alternating current wave-forms, by means of a Braun tube. In this arrangement the traverse motion of the kathode-ray beam across the screen is made to synchronise with the alternating-current deflection of the rays; thus the rays traverse the same path on the screen an unlimited number of times and a photographic time-exposure record can be obtained. A. B. W.

853. *Measurement of Current and Voltage in Alternating-Current Bridges.* **L. Hartshorn.** (Journ. Sci. Instruments, 3. pp. 87–89, Dec., 1925.)—In many a.c. bridge measurements it is necessary to make tests with a definite current flowing in the arm of the bridge containing the unknown; it is, moreover, not permissible to include an ammeter in the arm. The expedient often resorted to is to measure the total current supplied to the bridge and to calculate from the known settings of the arms when balance has been secured the fraction of this current that flows in the desired arm. Since the total current is rarely more than 1 or 2 milliamperes it is not possible to measure it with ordinary portable instruments. This difficulty may be overcome by shunting the bridge and supplying from the source a much larger current that can be readily measured; to find the fraction of this flowing in the required arm it is necessary to know not only the balance setting of the bridge, but also the relative impedances of the bridge and shunt. The author shows that the last-named condition may be removed by using as the shunt the Wagner earthing arrangement usually included for the purpose of adjusting the detector branch points to zero potential. The theory is given for a Heaviside-Campbell bridge and the proper value of the resistance in the Wagner earthing device to give shunt multipliers of 10, 100, or any desired value is worked out. The idea is applicable to any type of four-arm bridge, and can easily be modified to enable the voltage across a chosen arm to be determined in a similar way. B. H.

854. *An Alternating-Current Bridge for Measuring Small Phase Angles in High Resistances.* **I. Wolff.** (Optical Soc. America, J. and Rev. Sci. Inst. 11. pp. 629–635, Dec., 1925.)—An alternating current bridge is described which may be used for measuring large capacities in series with high resistances or small phase angles in high-resistance boxes. Using this bridge it is possible to compensate for the capacity and inductive effects in the standard resistance boxes and in the arms of the bridge. This correction is effected by the method developed for the adjustment of the Wagner earthing arm. Circuit equations are given to show the extent to which errors are eliminated, and experimental results in some typical cases are shown. AUTHOR.

855. *Ionic Relays.* **A. v. Engel.** (Zeits. techn. Physik, 6. 11. pp. 604–609, 1925.)—The properties of continuous current mercury-arc relays of the Burstyn type [Abstract 616 B (1924)] are discussed. The following points are dealt with: Minimum current, arc potential and anomalies, pressure limits, anode material, etc. A. W.

856. *Generation of Oscillations in Triodes.* **K. Rottgardt.** (Zeits. techn. Physik, 6. 11. pp. 610–614, 1925.)—A description is given of research on the generation of oscillations in triodes by the method termed by Kühn "field decay" (*Feldzerfall*). It is shown that with an oscillatory circuit connected between the anode and filament of a valve, the grid being connected to the anode by a suitable resistance, oscillations of frequencies varying from audio- to radio-frequencies may be obtained by raising gradually the anode voltage to a certain value, which value is determined by the resistance which short-circuits the anode and grid. Experiments illustrative of the principles involved are also described. A. W.

857. *Simplified Lecher Wires for Short-Wave Measurements.* **R. R. Ramsey.** (Optical Soc. America, J. and Rev. Sci. Inst. 11. pp. 641–644, Dec., 1925.)—A method of calibrating a wave-meter for short waves, 3 to 5 metres, using an ordinary amplifying tube and a B battery. Resonance is indicated by means of a milliammeter or voltmeter in the plate circuit of the tube. Data are given showing that the accuracy of the method is better than 1 %, the average deviation from the mean being about $\frac{1}{10}$ %. A simple wave-meter is described. AUTHOR.

ALTERNATING CURRENTS AND MAGNETISM.

858. *Vectorial Study of Some Fundamental Properties of Alternating Currents.* **O. Steels.** (Rev. Gén. d'Él. 18. pp. 929–932, Dec. 5, 1925.)—By using vectorial representation, and the elements of the symbolic method, the author demonstrates some of the fundamental formulæ in alternating-current technics. As an example of these methods of calculation he proceeds to determine the virtual value of a sinusoidal periodic function, and then extends the method to the case of non-sinusoidals. In addition, he establishes the expression for the power in a symmetrical polyphase system. A. E. C.

859. *Production of Maintained Oscillations.* **E.** and **H. Cartan.** (Annales des Postes, Télé. 14. pp. 1196–1207, Dec., 1925.)—Taking the equation

$$L\frac{d^2i}{dt^2} + [R - \phi(i)]\frac{di}{dt} + \frac{1}{C}i = 0$$

where L, R and C are constants and $\phi(i)$ is an even function decreasing with i, tending to zero as i tends to infinity with $\phi(o) > R$, it is shown that the curve representing the variation of i with t is formed of an infinite series of sinuosities, and is determined completely by the knowledge of the value of a single maximum or minimum. Further examination of the relative values of successive maxima and minima shows firstly that periodic solutions exist, and secondly that every solution tends either by increasing or decreasing amplitude towards such a periodic solution. The odd periodic solutions are stable, the even ones unstable. The obvious solution $i = 0$ is unstable, for the existence of any current, however small, leads by increasing amplitude to the first periodic solution. Upper and lower limits are found for both amplitude and period. The question is raised whether it could not be shown that there is only one maintained oscillation. G. A. S.

860. *The Influence of Grain Size on the Magnetic Properties of Silicon Alloys.* **O. v. Auwers.** (Zeits. techn. Physik, 6. 11. pp. 578–582, 1925.)—The paper is a criticism of previous results due to Yensen [see Abstract 2596 (1924)], who found that the loss of energy per cycle and grain size were related by the equation $W = 64\sqrt{N} + C$, where W is the loss and N the number of grains per mm.^{2}. It is considered that the relationship cannot be general since the influence of gas-content of the magnetic substance is neglected. Various experiments by the author on the magnetic properties of silicon irons do not confirm Yensen's conclusions. Coercive force, remanence and $\mu_{max.}$ have been investigated, as well as the grain size, and it is found that while the magnetic properties are undoubtedly

connected with grain size, precise relationship is not observed. Thus the metals were heated in atmospheres of hydrogen and nitrogen (as well as *in vacuo*), and it was found that whereas the grain size did not depend on the gas employed, the magnetic properties certainly did. W. V. M.

861. *Magnetostriction in Iron Crystals.* **W. L. Webster.** (Roy. Soc., Proc. 109. pp. 570–584, Dec. 1, 1925.)—From some large crystals of iron, rods were cut parallel to the three crystalline axes and tested for magnetostriction. For the (1.0.0) axis, increase of length was found for all magnetisations ; there was always a decrease in length for the (1.1.1) axis ; and along the (1.1.0) axis increase in length for weak fields was followed by decrease in length as magnetic saturation was approached. The last case is similar in behaviour to that of soft iron. The first is that of greatest permeability and greatest increase in length. Further experiments were made on the effect of stress on magnetisation, and the reciprocal relation between this effect and magnetostriction, given by Honda and Terada [Abstract 1578 (1907)], is verified. [See also Abstracts 2347 (1924) and 1744 (1925).] G. E. A.

862. *Glaser's Experiments and the Orientation of Molecules in a Magnetic Field.* **G. Breit.** (Washington Acad. Sci., J. 15. pp. 429–434, Nov. 19, 1925.)—It has been shown by Glaser that the diamagnetic susceptibility of H_2, N_2 and CO_2 is proportional to the pressure for sufficiently high pressures, but that at a certain pressure another non-linear law is followed [Abstract 607 (1925)]. Glaser and Debye suggest that the transition period is due to the finite time which is required for the establishment of space quantisation. The paper is a mathematical discussion of the laws which may govern the phenomena without precise assumptions as to the mechanism. Glaser's results show that the probabilities of orientation are not given by a simple exponential relation. W. V. M.

863. *Use of Stalloy Rings for Magnetic Shielding Purposes.* **D. W. Dye.** (Journ. Sci. Instruments, 3. pp. 65–69, Dec., 1925.)—A shield for a Paschen galvanometer was constructed from Stalloy rings snugly fitted round the instrument. The ratio of outer to inner diameter was about 1·3, and the height of the pile of rings was 1·25 times the outer diameter. This pile gave a shielding ratio of 34 in a field of 0·5 gauss. This method of building up screens from rings is of great utility when the space to be screened is of complex shape.

The paper also includes the results of calculations showing the screening effects of concentric iron cylinders. The earlier calculations on this problem use a value for the permeability of iron which is much lower than is obtained with Stalloy. Taking the permeability of this material as 400 the cases for 1, 2, 3 and 4 screens have been worked out. The data plotted show the screening ratio against the ratio of the outside diameter to the inside diameter of the whole system. A. A. D.

864. *Paramagnetism of Salts of Cobalt in Solution.* **Chatillon.** (Comptes Rendus, 181. pp. 778–780, Nov. 23, 1925.)—These salts are known to occur in two states, one of which is characterised by a constant atomic moment of 24·5 magnetons [see Abstract 1835 (1921)]. On investigating the chloride, sulphate and nitrate of cobalt in solutions between 10° and 140°, the Curie point is calculated as — 12° C. for all

the salts, and the number of magnetons is 25. For the anhydrous sulphate, Serres found 26 magnetons; the author confirms this number for the salt in solution, the Curie point being now — 33° C. By recrystallisation, solutions are obtained in which the number of magnetons is again 25.
G. E. A.

865. *Measurement of the Four Magnetic Transverse Effects.* **E. H. Hall.** (Phys. Rev. 26. pp. 820–840, Dec., 1925.)—This paper presents in detail the experimental arrangements and technique used by the author in measuring the four magnetic transverse effects (the Hall, Ettingshausen, Nernst and Leduc effects) on the same strip of metal, in succession. The strip, 5 cm. long by 2 cm. wide by 0·01 to 0·06 cm. thick, depending on the metal, is soldered to two brass end blocks which may be independently cooled or heated with water or steam. The pole pieces, 4·5 cm. in diameter and 0·7 cm. apart, are thermally insulated from the strip by flannel and mica. The temperature of these pole pieces is adjusted to approximately that of the middle of the strip, by water cooling or heating. Ten thermojunctions are soldered at various points along one edge and along the median line of the strip, and one at the middle of the other edge. These enable longitudinal and transverse potential and temperature gradients to be measured. Various corrections are discussed, including (*a*) effect of size of thermojunctions, (*b*) the effect of the limited length of the strip with reference to the width, (*c*) masking influence of one transverse effect on another, (*d*) effects of non-uniformity of temperature gradients due to heat leakage to or from the strip. Also certain precautions in the measurement of the separate effects are given. Results for Au, Pd, Ni, Co, previously published in summary, are here given with some details, including corrected values for the Ettingshausen-effect for palladium. AUTHOR.

866. *The Magnetic Anomaly of Koursk.* **P. Lasareff.** (Comptes Rendus, 181. pp. 1150–1151, Dec. 28, 1925.)—Further work at Koursk has proved the hypothesis that the magnetic anomaly is due to a deposit of magnetite [see Abstract 423 (1925)]. The minimum anomaly at Tim is probably caused by the fact that the magnetite there has been largely oxidised to hæmatite. On the hypothesis that the iron content along the length of the anomalous region is proportional to the vertical component, the metallic iron content of the band is about $0{\cdot}8 \times 10^{10}$ metric tons. If, on the contrary, it be assumed that the iron is uniformly distributed, but in places partially converted to non-magnetic oxide, the total metallic iron would be about 2×10^{10} metric tons. W. A. R.

RADIOGRAPHY AND ELECTRO-PHYSIOLOGY.

867. *Interpretation of Radioscopic Images.* **R. Lambolez.** (Archives d'El. Médicale, 33. pp. 228–230, Dec., 1925.)—The image seen upon a fluoroscopic X-ray screen is inaccurate, since the tint of the image varies both with the degree of the previous absorption of radiation and as the inverse square law, the latter being of special importance when a large screen is used. Further, the image varies relatively to variations of tube, object and screen distances. To avoid penumbras a point source would be necessary. The paper deals with geometric methods to determine the exact position in space of a body casting a radioscopic image. B. J. L.

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

868. *Influence of Adsorption on the Colour of Sols and of Precipitates.* **N. R. Dhar.** (J. Phys. Chem. 29. pp. 1394–1399, Nov., 1925.)—Various instances are discussed in which the colour of a positively charged sol differs from that of the negatively charged sol of the same substance, or from that of the electrolyte from which the sol is prepared. The colour of freshly precipitated manganese dioxide, ferric hydroxide, etc., depends largely on the nature of the substance adsorbed by the precipitates in the course of their formation. The blue colour of adsorption compounds of iodine with starch, dextrin, cholalic acid, basic lanthanum acetate, etc., appears to be due to the presence in such compounds of iodine in the colloidal condition. T. H. P.

869. *Derivation of Adsorption Isotherms.* **A. Gorbatschew.** (Zeits. phys. Chem. 118. pp. 357–360, Dec. 30, 1925.)—From a consideration of the energy change which occurs during adsorption the following relations are derived : $f(x) = CA/M$ and $x = C/M \,.\, dK/dx$, where x is the concentration of gas in the adsorbed layer, C that in the gas phase, A is the work which the adsorbed molecule performs against the attractive force in leaving the adsorbed layer, K is the force of attraction, and M a constant. The latter equation is seen to be closely analagous to the Gibbs relation $x = -C/N \,.\, d\sigma/dc$, where σ is the surface tension. By employing Henry's law $x = mc$, the exponential formula $x = ac^{1/n}$, or the Langmuir formula $x = ac/1+\beta c$, the following expressions relating to solutions are obtained : $\sigma_M - \sigma_L = mNc = anNc^{1/n} = aN/\beta \,.\, ln(\beta c + 1)$, where σ_M is the surface tension of the solvent, σ_L that of the solution, and σ_M, N, m, n, a and β are constants for a given system. These relations are found to be analagous to the formulæ derived by Freundlich and v. Szyszkowski. [See Abstract 2767 (1925).] J. N. P.

870. *Determination of Avogadro's Constant by Means of a Birefracting Solution of Dialised Iron.* **L. Tieri.** (N. Cimento, 2. pp. 351–361, Oct.–Nov.–Dec., 1925. Accad. Lincei, Atti, 2. pp. 331–334, Nov. 1, 1925.) —A curve here given seems to demonstrate that liquids, which by ultramicroscopic examination appear to have only one kind of granule in suspension, contain granules of diverse size. It is shown that the differences in values obtained for N are probably due in great part to the hypothesis made as to the form of the granules. A. E. G.

871. *Influence of the Ionic Magnitude on the Equation of State of Strong Electrolytes.* **J. Frenkel** and **B. Finkelstein.** (Zeits. f. Physik, 35. 3. pp. 239–242, 1925.)—An equation of state is developed for solutions of strong electrolytes, analagous to the van der Waals equation for gases, from the relation $(p_0 + p_e)(v - b) = \frac{2}{3}L$, where p_0 = osmotic pressure of solution, p_e = internal pressure of ions, b = a factor depending on the size of the ions, L = average kinetic energy of dissolved substance. From this expression, using the thermodynamical methods developed by Noyes, a function is derived by which the ionic radius can be calculated, using the

activity coefficient of the solution. The values calculated in this way for LiCl, NaCl, KCl are very nearly constant at various concentrations.
B. W. C.

872. *Dissolution of Zinc in Acid in Presence of Other Metals. Catalysis and Supertension.* **M. Centnerszwer** and **M. Straumanis.** (Zeits. phys. Chem. 118. pp. 438–446, Dec. 30, 1925.)—When zinc is placed in sulphuric acid, in the presence of metals, or when these metals are first electrolytically deposited on the zinc, the supertension of the hydrogen depends upon the metal deposited and upon the surface condition of the zinc. The supertension is high when the hydrogen is liberated in large bubbles (from smooth surfaces), and small (and the liquid looks milky) when the deposit is spongy. According to Ericson-Aurén and Palmaer, the presence of other metals should catalytically accelerate the dissolving of the zinc, when the supertension is smaller than 0·78 volt, but this is found not to hold for Cd, Sn, Pb, though the supertensions are smaller. This is not because these metals form protective coatings on the zinc. There is no direct connection between the supertension, which has a certain minimum for each metal, and the catalytic effect. The local couples are indeed connected with the rate of dissolution, but they are not its primary cause; they are themselves caused by the dissolution which they must accompany, as the process depends upon the formation and displacement of ions. The authors thus uphold Ostwald's view. H. B.

873. *On the Presence of Air in Pure and in Alkaline Water.* **J. Porter.** (Roy. Techn. Coll. Glasgow, J. No. 2. pp. 19–25, Dec., 1925.)—The solubility of air at normal pressure in pure and in alkaline water at various temperatures is illustrated by means of graphs. The form of the graph for pure water shows that when water is raised in temperature from, say, 15° to 80° C. much air ought to come out of solution during the early stages of heating. But direct experiments are referred to and new experiments described, showing that little air may be evolved on heating water until after 80° or even 95° C. is reached. The question arises, does the air which is not evolved, as it ought to be, on heating, remain in the water in an unstable supersaturated condition, or does it come out of solution to form a layer so firmly bound to the surface of the vessel as to have no appreciable volume? Experiments are described which favour the latter supposition. It is further shown, however, that by maintaining the temperature of water at, say, 60° C. for two or three hours, more and more air is liberated until ultimately all that can come out of solution is evolved. Experiments are also described giving, for particular cases, the rates at which hot water, which had been thoroughly de-aerated by boiling, re-absorbed air from the atmosphere. AUTHOR.

874. *Influence of Hydrogen-Ion Concentration on Dialysis Velocity.* **H. Mommsen.** (Zeits. phys. Chem. 118. pp. 347–356, Dec. 30, 1925.)—Measurements are made of the rates of dialysis through a parchment membrane of the non-electrolytes ammonia and sucrose when alone in water, and when in presence of dilute acid and alkali. In experiments in which a regulated pressure is applied the rate of diffusion is measured when alone or in presence of dilute acid or alkali. It is concluded that though the rate of passage of ions is, as found by Terada, largely affected by change of the *p*H values, the effect cannot be due to a change in the permeability of the membrane. By forcing pure water, 1/500 N. sodium hydroxide or

1/500 N. hydrochloric acid through the membrane, no difference in the diffusion rate can be detected. The dialysis velocity of the non-electrolytes ammonia and sucrose is not affected by an alkaline medium, while with acids a very small increase in the velocity is produced. With electrolytes increase of the *p*H values increases the dialysis rate of anions, and diminution of the *p*H value increases that of kations. This opposed effect is probably due to changes in the charge on the membrane, which only exerts a small effect on non-electrolytes. J. N. P.

875. *Viscosity of Colloids in Presence of Electrolytes.* **N. R. Dhar.** (J. Phys. Chem. 29. pp. 1556–1567, Dec., 1925.)—The results obtained by various authors for the viscosities of colloids, especially those of the hydrophobe type, are in agreement with the following assumptions [see Abstract 2621 (1925)]. If other things are equal, the uncharged substance is more highly hydrated than the sol; the viscosity of a substance increases with its degree of hydration; when a sol adsorbs an ion carrying the same charge as the sol owing to chemical affinity, the charge on the sol is increased, and the viscosity of the sol should decrease; sols behaving abnormally on dilution and towards a mixture of electrolytes and exhibiting positive acclimatisation, will show greater decrease of viscosity on addition of small amounts of coagulating electrolyte than sols showing the opposite properties; when the sol adsorbs more of the ion carrying the opposite than of that carrying the same charge as itself, the charge on the sol will be decreased and the hydration and viscosity increased.

The diminution of the surface tension of a solvent by gelatine, albumin, etc., is explainable on the assumption that the particles of these substances tend naturally to disintegrate. With the isoelectric gelatin the suspended particles are assumed to disintegrate, the smaller particles then adsorbing more water and the viscosity of the system being thus increased. When acid or alkali is added, the charge on the sol is increased by the preferential adsorption of hydrogen or hydroxyl ions, the tendency to disintegrate and the hydration and viscosity are thus increased. T. H. P.

876. *Behaviour of Silica Gel towards Certain Alkalies and Salts in Aqueous Solution.* **W. A. Patrick** and **E. H. Barclay.** (J. Phys. Chem. 29. pp. 1400–1405, Nov., 1925.)—The experiments here described consisted in treating certain samples of silica gel with sodium hydroxide solutions and, after the attainment of equilibrium, determining the amount of alkali adsorbed by measuring the change in concentration of the solution. The gel containing the adsorbed alkali was quickly rinsed and immersed in a solution of either copper or silver nitrate or ferric sulphate, the replacement of the sodium being determined. The extent to which sodium hydroxide is removed from solution by silica gel increases with the concentration of the alkali, the subsequent replacement of the sodium ions by other ions being in accordance with stoichiometric laws. Definition of adsorption as a phenomenon giving rise to a relationship expressible by the Freundlich adsorption equation, $X/M = KC^{1/n}$, requires the existence of various types of adsorption phenomena, which may be classified as (1) chemical, (2) molecular layer, and (3) capillary. Increase in the rate of adsorption of alkali with the concentration of the latter is explainable on the assumption that the alkali peptises the silica gel, that is, makes the silica particles smaller, or that the thickness of the alkali "layer" increases

as the amount of alkali in solution increases. Thus, the retention of alkali by silica gel must be regarded as due to the action of chemical forces.
T. H. P.

877. *Determination of Size of Colloidal Particles by Means of Alternating Electric Fields.* **E. F. Burton** and **(Miss) B. M. Reid.** (Phil. Mag. 50. pp. 1221–1226, Dec., 1925.)—Investigations have been made of a number of copper sols prepared by sparking with an electric arc beneath the surface of samples of conductivity water containing potassium hydroxide in various small proportions. Measurements were made of the settling of the particles of these sols in a **U**-tube over a period of seven hours, an electric field being applied during the whole period and changed in direction at intervals of 1·5 minutes. The size of particle, calculated in accordance with Stokes' law, increases with the amount of alkali present in the water. Further, the size of particle for which the calculated velocities due to gravitation and to the Brownian movement become equal is not very far removed from that indicated by the results of the above measurements.
T. H. P.

878. *Allotropy of Zinc.* **D. Stockdale.** (Chem. Soc., J. 127. pp. 2951–2956, Dec., 1925.)—Using electrodes of pure Zn, separated by an electrolyte containing the chloride, with smaller quantities of bromide and oxychloride of Zn, in a specially designed apparatus, determinations are made under heating and cooling conditions yielding curves relating e.m.f. to time. These curves confirm previous conclusions that Zn undergoes allotropic change between 310° C. and 330° C.—the transformation point at 315° C. being suggested with reserve. A. B. C. L.

879. *Elastic Properties of Alloys. Variation with Chemical Composition.* **P. Chevenard** and **A. Portevin.** (Comptes Rendus, 181. pp. 780–782, Nov. 23, 1925.)—Curves are given which exhibit the changes in the elastic modulus μ, its temperature coefficient $(\partial\mu/\partial\theta)/\mu$ and decrement, for binary metallic alloys at ordinary temperature. The cases are distinguished in which the alloys are constituted of aggregates of two phases and those of solid solution or one phase of variable concentration. It is concluded that the elastic modulus of an alloy varies as an almost linear function of the chemical composition, and is affected only in a secondary way by the structure of the alloy. It is considered that the value of the modulus cannot be increased to the same extent as the tenacity or hardness by alloying or other treatment. Variation of the decrement with composition deviates from the linear law especially in solid solutions which approximate to pure metals. G. E. A.

880. *The Temper of Light Aluminium-Copper Alloys containing More than 5 % Copper.* **L. Guillet** and **J. Galibourg.** (Comptes Rendus, 181. pp. 1107–1108, Dec. 28, 1925.)—This investigation extends previous work [see Abstract 2534 (1923)], the results being included in a table which expresses the variations of hardness and tenacity observed for tempered alloys whose copper content varies from 7 to 45 %. It is found that the hardness is sometimes doubled after the optimum treatment. Micrographic examination has revealed analogous phenomena to those of duralumin. The compound Al_2Cu has been identified as precipitated throughout some of the alloys. The series is remarkable in that no transformation point occurs. H. H. Ho.

881. *The System Aluminium-Zinc.* **O. Tiedemann.** (Zeits. f. Metallkunde, 16. pp. 18–21, Jan., 1926.)—Preliminary experiments on the electrical conductivity of aluminium-zinc alloys, containing up to 15 % zinc, at rising and falling temperatures, showed that changes took place in the system which was held to be homogeneous. The alloys were annealed for a number of times, 3 to 11, for twenty-four-hour periods. The temperatures ranged from 240° C. to 500° C., and the tensile strength and elongation of the annealed metal was determined. From the results obtained the equilibrium diagram of the aluminium-zinc alloys containing up to 25 % zinc is somewhat modified. F. J. B.

882. *Mechanism of the Photochemical Reaction between Hydrogen and Chlorine. II.* **A. L. Marshall.** (J. Phys. Chem. 29. pp. 1453–1461, Nov., 1925.)—In continuation of a previous research [see Abstract 2394 (1925)], hydrogen and chlorine are submitted to the action of light from a quartz Hg arc at pressures ranging from 0·0001 to 6·0 cm. The quantum yield is found to increase from about 20 to over 25,000 molecules. At a total pressure of 5·9 cm. the quantum yield is independent of light intensity when the latter is increased by twenty times. This is in direct contradiction to the results of Baly and Barker [see Abstract 1741 (1922)], who observed a sixty-fold increase in reaction velocity for a twenty-fold increase in light intensity for mixtures of constant composition.

A. B. C. L.

883. *Influence of Pressure on Equilibrium in Binary Systems. II. Urethane-Benzene.* **N. A. Puschin.** (Zeits. phys. Chem. 118. pp. 447–459, Dec. 30, 1925.)—Cooling curves are plotted for binary mixtures of urethane and benzene in varying proportions at constant pressures which, in different experiments, vary from 1 to 4000 kg./cm.^{2}, the freezing-points and eutectic points are thus determined and the phase relations plotted. The compounds have been selected through possessing a large difference in the change of freezing-point with pressure, the freezing-point of benzene ranging from 5·5° C. at atmospheric pressure to 93·2° C. at 4000 kg./cm.^{2}, while the corresponding values for urethane are 58·3° C. and 74·6° C. It is inferred from an examination of the curves that the order of crystallisation of the components can be changed by applying certain pressures. At atmospheric pressure urethane separates first, while at 3550 kg./cm.^{2} the order is reversed and benzene separates first, or urethane, which at ordinary pressures is the solute, becomes at higher pressures the solvent and only crystallises at a corresponding eutectic temperature. The crystallising temperature and the composition of the eutectic mixture are also markedly displaced by pressure, the latter changing from 4·4 % urethane at atmospheric pressure to 80 % at a pressure of 4050 kg./cm.^{2}. In accordance with theory, the influence of pressure on the composition of the eutectic is to increase the content of the component which has the smaller coefficient dT/dp. [See Abstract 624 (1926).] J. N. P.

884. *Hydrogen Exponent of Water.* **A. Kling** and **A. Lassieur.** (Comptes Rendus, 181. pp. 1062–1064, Dec. 21, 1925.)—A single distillation of water in a closed platinum apparatus gives a liquid of pH = about 5·8, provided that any traces of ammonia originally present are eliminated by rendering the water alkaline and discarding the first portion of the distillate. This reaction then remains constant and is not

altered by further purification, such as distillation in presence of acid or alkali, fractional crystallisation, even when these operations are effected in total absence of carbon dioxide. In an atmosphere of normal composition, such water does not alter in hydrogen-ion concentration when stored in a platinum or Jena glass vessel, either stoppered or unstoppered. This acidity corresponds with that of a 0·00001 N solution of carbon dioxide, but the water requires from five to six times the amount of baryta that such a carbon dioxide solution should need. T. H. P.

885. *Rusting of Iron.* **W. Kistiakowsky.** (Zeits. Elektrochem. 31. pp. 625–631, Dec., 1925.)—The rusting of iron is considered from both the physical and the chemical standpoints. As regards the former, the first stage of rusting consists of a vitreous layer of oxide which, when it completely covers the surface of the metal, renders the latter passive. This layer then undergoes crystallisation, etc., the result being the formation of pores and of consequent irregularity in the surface, thus leading, in electrolytes, to local currents and, in air, to rusting. Five conditions of the iron surface may be distinguished : superactive, active, subactive, subpassive, and passive. The porous oxide layer corresponds with the subactive (large pores) and subpassive (small pores) states, which form the region of rusting. The amorphous passive skin is present on the surface of even iron (or nickel, chromium, etc.) having metallic lustre. The spontaneous amalgamation of steel when broken under mercury in entire absence of oxygen favours the theory that the oxide layer is the cause of passivity and shows that the normal condition of iron is active and that passivity is caused by the oxygen. The chemical problem of rusting deals with the action of reagents. The acceleration of the solution of iron in neutral electrolytes by carbon dioxide is regarded as due to a depolarising action of the gas. Experiment shows that, in electrolytes containing sodium ions, sodium carbonate is formed on the passive parts of the metal by local currents and ferrous salt on the active parts ; diffusion brings these two products into contact, with formation of ferrous oxide and, by oxidation, ferric oxide. T. H. P.

886. *Derivation of the Equation for the Effect of Temperature on Reaction Rate.* **R. C. Tolman.** (Am. Chem. Soc., J. 47. pp. 2652–2661, Nov., 1925.)—The equation $-dC/dt = kC = k'e^{-E/RT}.C$, connecting the velocity of unimolecular reactions of the first order with temperature and energy of activation has usually been derived either on the assumption of a rate of activation fast enough to maintain the full Maxwell-Boltzmann quota of activated molecules, or on the assumption that the activational process consists in the absorption of radiation. A derivation is now presented which makes no specific assumptions as to either the rate or mechanism of activation, so that the above equation will be valid, at least approximately, under a wide variety of conditions. Further, the equation connecting the rate of bimolecular reactions of the second order with temperature and energy of activation, namely, $-dC/dt = kCC' = k'T^{\frac{1}{2}}e^{-[(E+E')/RT]}CC'$, is derived, assuming either that the reacting molecules have received their energies of activation prior to the collision which leads to reaction or that the processes of activation and reaction are merged in one collision having sufficient available kinetic energy. The necessity of discovering mechanisms of activation which will supply sufficiently rapidly the large energies of activation calculated from the

above two equations is emphasised. Since the quantity E occurring in the first equation is the excess per mol. in the energy of the molecules that react over the average energy of the unactivated molecules, it cannot be assumed that this average energy is available as part of the energy of activation. T. H. P.

887. *Chemical Action of Gaseous Ions produced by α-Particles. VI. Reactions of the Oxides of Carbon.* **S. C. Lind** and **D. C. Bardwell.** (Am. Chem. Soc., J. 47. pp. 2675–2697, Nov., 1925.)—The ratio of the number of molecules reacting chemically (M) to the number of ions (N) when the chemical reaction takes place under the influence of α-radiation is discussed. The reactions considered are the decomposition and reduction by hydrogen of CO and CO_2, and the oxidation of CO. The amount of chemical action is measured either directly by chemical analysis or by following the course of the change of pressure and controlling its interpretation by chemical analysis after the completion of the reaction. Comparison is made with a paper of J. J. Thomson [see Abstract 1312 (1924)], who treated the subject of the chemical behaviour of gaseous ions electrodynamically, and his conclusions agree, in most cases, with the experimental α-ray results of the authors. The two factors which may raise the M/N value by a few integers above unity are : the clustering of neutral molecules about ions, and the equality of action of positive and negative ions. These were deduced by Thomson, and are both confirmed experimentally. A new experimental apparatus for making the measurements is described. [See also Abstract 136 (1925).] H. N. A.

888. *Specific Affinity as a Function of Derived Variables.* **G. van Lerberghe.** (Comptes Rendus, 181. pp. 851–853, Nov. 30, 1925.)—Donder [see Abstracts 2183 and 2391 (1925)] has introduced the fundamental idea of the specific heat of a system in connection with work on the non-compensated heat of Clausius. The present author now expresses this specific affinity by means of special variables (fugacities) and derives their explicit values : § 1 considers partial affinities generally, § 2 dealing with the perfect gas, § 3 investigates any system whatever and finds that the partial affinity of the constituent ν takes the form of $RT(\log k_\nu - \log f_\nu)$, where k is the chemical function and f the fugacity, a complicated mathematical expression being derived for the latter for which the paper should be consulted. H. H. Ho.

889. *Chemical Statics of Electronic Phenomena.* **L. Rolla** and **G. Piccardi.** (Accad. Lincei, Atti, 2. pp. 173–177, Sept., 1925.)—The ionisation potential of an element is independent of the temperature. Hence the authors integrate the van't Hoff isochore and put T = constant, obtaining U as a linear function of log K. A graph is shown for the elements Cs, Ba, Sr, Ti, Mo and Cu for one particular experimental condition, the ordinates being values of log K and the abscissæ the ionisation potentials. The points lie on a straight line. Another series includes Cs, Rb, K, Na, Li and Tl, and in this case it is pointed out that log K has a value zero between 8 and 9 volts, thus falling well into line with the statement previously made that, in the ordinary Bunsen flame, elements with ionisation potentials above about 8 volts are not ionised. Taking the temperature of the flame to be 1750° abs., the calculated slope of the line is 109°, which is very close to the actual value. Taking the experimental values of ionisation potential and log K for Cs and Tl,

and the corresponding values for log K for some other elements, a comparison between a number of calculated and observed ionisation potentials is given. The agreement is within one or two in the first decimal place. A. Wh.

890. *Application of X-Ray Crystallography to the Structure of Nickel Catalysts.* **G. L. Clark, W. C. Asbury** and **R. M. Wick.** (Am. Chem. Soc., J. 47. pp. 2661–2671, Nov., 1925.)—Using a specially designed, inexpensive, but precise spectrograph, powder diffraction photographs are taken of Ni catalysts of widely different hydrogenation and dehydrogenation activities, prepared by reduction with C, $\overline{\text{Et}}\text{OH}$, $\overline{\text{Et}}\,\overline{\text{A}}$, H and Na_3PO_2. Except for the last, which appears colloidal, all give identical lines for Ni, $d_{100} = 3{\cdot}536$ Å. Hence the difference in activities is not to be ascribed to a difference in lattice type or dimensions. The relative intensities and width of the lines, measured by precision photodensitometer curves prepared from the films are all approximately the same, and in fair agreement with the calculated values for a face-centred lattice. The Ni catalysts do not obey the Debye-Scherrer equation connecting line width with particle size, defined for colloidal dimensions. A rough parallelism is found between decreasing line width and increasing catalytic activity. X-rays give no information concerning the surface of catalysts. Precision measurements on NiO (simple cubic) give $d_{100} = 4{\cdot}16$ Å. Ni_2O_3 gives only the lines of NiO, suggesting the composition $NiO\,.\,NiO_2$, since the two forms of NiO_2 give no diffraction lines. Ni_3O_4 is also amorphous. A. B. C. L.

891. *Effects of Knock Inducers and Suppressors upon Gaseous Ionisation.* **G. L. Clark, E. W. Brugmann** and **W. C. Thee.** (Indust. and Engin. Chem. 17. pp. 1226–1229, Dec., 1925.)—It is well known that the presence of as little as one molecule of tetra-ethyl lead in 200,000 molecules of combustible mixture of petrol and air exerts a marked effect in the suppression of detonation. One theory of this "anti-knock" action is that the lead atom absorbs electrons in the wave front, thus retarding the velocity of propagation, and experiments by Wendt and Grimm (*Ibid.*, 16. p. 890, 1924) indicated that when tetra-ethyl lead-vapour at room-temperature and pressure was added to an ionised but not burning gas the rate of recombination of ions was increased by 370 %. The present authors have repeated the experiments of Wendt and Grimm under carefully controlled conditions, but using molybdenum Kα X-rays as an ionising source, and a quadrant electrometer and a gold-leaf electroscope for the measurement of ionisation currents. The ionisations of air, air plus benzene, and air plus benzene plus various knock suppressors (as tetra-ethyl lead) and inducers (as butyl nitrite), were determined. The experiments show that the theory of electron wave fronts in explosions and the absorption of electrons by knock suppressors is not sufficient to explain the facts, Wendt and Grimm's results not being confirmed. Several theories of the action of knock suppressors are critically examined, the conclusion being that the detonation wave theory, according to which high pressures in the wave front give rise to arbitrary motions producing sound, is subject to least objection. Suggestions for further work are put forward. T. B.

892. *An Electrometric and a Phase Rule Study of Some Basic Salts of Copper.* **H. T. S. Britton.** (Chem. Soc., J. 127. pp. 2796–2807,

Dec., 1925.)—The mode of precipitation of copper sulphate by sodium hydroxide is studied by conducting electrometric titrations with a copper electrode. According to the manner of mixing and the quantity of alkali used, either apparently amorphous or gelatinous precipitates may be obtained by adding alkalis to solutions of the sulphate, chloride, bromide, or nitrate of copper. The individualities of the basic salts $Cu_4(OH)_6SO_4,H_2O$ and $Cu_4(OH)_6Cl_2,H_2O$ are established. The behaviour of the $Cu/Cu(OH)_2,NaOH$ electrode is shown to be erratic, and the value of Jellinek and Gordon for $[Cu'']{[OH']}^2$ untrustworthy. Observations are made on the darkening of suspensions of basic copper salts on boiling. The constitutions of the basic salts are discussed with special reference to Werner's coordination theory. J. N. P.

893. *Action of Silica on Electrolytes. II.* **A. F. Joseph** and **H. B. Oakley.** (Chem. Soc., J. 127. pp. 2813–2818, Dec., 1925.)—The action of an alkali hydroxide solution on silica [see Abstract 2526 (1923)] at 33° to 38° results in the formation of a solid silicate, part of which passes into solution. The amount of solid silicate formed is very small with sodium and potassium hydroxides, and is about 50 % with barium, and nearly 100 % with calcium hydroxide. These results are in accordance with the solubilities of the respective silicates. In the case of sodium and potassium, the small amount of solid silicate produced is approximately proportional to the weight of silica taken, but the amount of dissolved silicate is not greatly affected; evidently the solid phases (silica and silicate) are concerned directly in the equilibrium. The addition of a neutral salt increases considerably the amount of solid silicate produced. T. H. P.

894. *Formation of Ozone by Electron Impact.* **F. Krüger** and **O. Utesch.** (Ann. d. Physik, 78. 2. pp. 113–156, Nov., 1925.)—The results are given of experiments on the formation of ozone in flowing oxygen by the impact of kathode-rays which have passed through a Lenard window. The number of ozone molecules formed per unit of time is found to be from twenty to forty times as great as the number of ions formed in the oxygen. The equivalence found by Moeller (Dissertation, Danzig, 1912) between the number of the ions formed in nitrogen and the number of ozone molecules formed in oxygen with the same intensity of kathode-rays is not, however, confirmed. On the contrary, in conformity with Lenard's law and McLennan's measurements [Abstract 99 (1901)], the secondary radiation in nitrogen, air and hydrogen is proportional to the mass, the influence of chemical reactions on the secondary radiation produced, assumed by Moeller, being not observed. Thus, formation of ozone by kathode-rays is not connected with ionisation, but is due, as would be expected from the photochemical formation of ozone, to impact of oxygen molecules "excited" by the impacts of electrons with others not excited. The amount of ozone formed varies with the velocity of the gas, the voltage and the current, and, for the Lenard window used, is at most 150 grammes per amp.-hour. The energy of the kathode-rays emerging from the Lenard window is thus only 3 % to 5 % of the electrical energy employed. Investigation of the energy balance shows that for ionisation or secondary radiation from 2% to 4 % and for ozone-formation from 5 % to 11 % of the total energy is used, the remaining 80 % to 90 % being converted into heat. T. H. P.

895. *The Structure of Silicon Tetrachloride.* **G. Joos.** (Phys. Zeits. 26. pp. 734–737, Dec. 8, 1925.)—From data determined by Fowler on the ionisation voltage of silicon [Abstract 2093 (1925)] a calculation is made of the electron affinity or the energy involved in the ionisation of silicon. The corresponding value for chlorine is obtained from spectrographic data. From these values, the heat of vaporisation of silicon, and the chemical heat of reaction in the formation of silicon tetrachloride, it is calculated that the heat evolution in the reaction between Si^{++++} and $4Cl^{-}$ amounts to 2307 kg. cal. per grm. mol. A calculation of this magnitude is then made from a consideration of the electrostatic forces in operation in the molecule on the basis that this has the form of a regular tetrahedron with Si^{++++} in the centre and Cl^{-} at the corners, the distance of their centres being 2·59 Å.U. from each other. The value derived in this way is 2847 kg. cal. per grm. mol. The discrepancies between these two values will disappear if an increase of 7 % in the radius of the sphere of electrons of the chlorine atom, and consequently in the dimensions of the molecule, is allowed for. [See Abstract 2239 (1924).] J. N. P.

896. *Determination of Transition Points in Non-Aqueous Solutions by the Electromotive Force Method.* **R. B. Mason** and **J. H. Mathews.** (J. Phys. Chem. 29. pp. 1507–1516, Dec., 1925.)—With the object of showing that electrical methods may be employed in the determination of the transition temperatures of non-aqueous solutions, a number of cells made up with solutions of inorganic salts in anhydrous pyridine are studied. There is a sharp break in the temperature-e.m.f. curve at 55° C. for the half-cell Cu–Hg . $CuCl_2$. 2py when connected to either the half-cell $HgCl_2$. 2py . Hg or $CdCl_2$. 2py . Cd–Hg. This break is evidently due to the transition of $CuCl_2$. 2py into $3CuCl_2$. py. Due to secondary chemical reactions, the e.m.f. of the $CuCl_2$ cell gradually changes. The temperature-conductance curve shows a break at approximately 56° C. From the standpoint of conductance, stability, and reproducibility, the most satisfactory cell combination tried is

$$Cd–Hg|CdCl_2 . 2py|\text{sat. solution of } ZnCl_2|ZnCl_2 . 2py|Zn–Hg.$$

The temperature-e.m.f. curve breaks sharply at 9·3° C., the temperature at which the compounds $CdCl_2$. 6py and $CdCl_2$. 2py are in equilibrium. This value is in good agreement with that obtained by the solubility method (9·0° C.). The Cd and Zn amalgams change polarity on heating the cell :—

$$Pb–Hg|PbCl_2 . 2py|\text{sat. solution of } PbCl_2|CdCl_2 . 2py|Cd–Hg.$$

This reversal is apparently an irreversible change, although there is some indication of a transition point at 53° C. A. B. C. L.

897. *Measuring the Relative Surface Charges of Electrolytes.* **A. Garrison.** (J. Phys. Chem. 29. pp. 1517–1522, Dec., 1925.)—An electric condenser is formed in which the electrolyte contained in a cylindrical glass vessel forms one plate and a horizontal metal plate is arranged above. The electrolyte is connected through a glass tube to a normal calomel electrode, the mercury of which connects with one pair of quadrants of an electrometer while a wire from the second leads through a potentiometer to the metal plate of the condenser. The potential of the plate

is thus adjusted so that no charge is induced when the capacity of the condenser is changed by raising the plate. The reading of the potentiometer then gives the potential difference between the electrolyte surface and the reference plate if they had both been earthed. The surface charge on distilled water is found to vary largely and to have an average value of 0·040 volt. The charge is displaced appreciably by the smallest traces of substances of an oily nature. Measurements made with a large number of compounds at varying concentrations show that the largest effects on the surface charge are produced by the first traces of the substance added, and that the subsequent additions produce relatively little change. In some cases the effect appears to approach a maximum at a low concentration, and on further addition of solute the charge is reduced and sometimes reversed in sign. The general relations between concentration and surface charge are found to be similar to the relations between concentration and adsorption. The hydrogen ion, which is noted for its power of precipitating colloidal suspensions, is found to have the largest influence on the surface charge of water. [See Abstract 1987 (1925).] J. N. P.

898. *Potential Difference and Equilibrium across a Semi-permeable Collodion Membrane in the Case of Sodium Chloride and Congo Red.* **R. Azuma** and **N. Kameyama.** (Phil. Mag. 50. pp. 1264–1276, Dec., 1925.)—The authors record measurements for aqueous solutions of sodium chloride and of sodium chloride plus Congo Red, and include very full experimental and apparatus details. When Congo Red in the range of concentrations measured is assumed to ionise as a uni-univalent electrolyte, and on the assumption also that the ionic strength principle of G. N. Lewis holds good for the mixtures of Congo Red and sodium chloride used, the experimental results are in general agreement with the thermodynamical requirement of the equality of the activities of sodium chloride on either side of the membrane. Owing to the difficulty of eliminating liquid-liquid potentials in solutions containing Congo Red, it has not been possible to prove that the potential difference across the membrane is in agreement with the thermodynamical requirement for a system in equilibrium. H. H. Ho.

899. *Dissociation of Weak Electrolytes in Aqueous-Ethyl Alcohol and Aqueous-Methyl Alcohol Solutions.* **M. Mizutani.** (Zeits. phys. Chem. 118. pp. 318–326 and 327–341, Dec., 1925.)—Measurements are made by means of a hydrogen electrode of the logarithmic dissociation constants or pK values of a number of dibasic and other acids, and of a number of bases in aqueous-ethyl alcohol and in aqueous-methyl alcohol solutions as in an earlier investigation [Abstract 2192 (1925)]. The results with different compounds are expressed graphically by plotting the departure of the pK values from those with aqueous solutions against the percentage alcohol content of the solution. The influence of constitution is investigated by measurements with oxalic, succinic, malic, lactic, glycolic, malonic, fumaric, phthalic, glutaric and chloracetic acids. With acids of two carboxyl groups distantly arranged from each other in the molecule, the pK value for each group is equally displaced by alcohol. When adjacent, however, the displacement of the first group is greater, and that of the second less, than for the related mono-carboxyl acid. The displacement by methyl alcohol is less than by ethyl alcohol, but the graphs

with the two solvent mixtures are closely parallel. In all cases a great regularity is observed in the results, and constitutional influences only exert a minor effect. A reduction is brought about in the dissociation constants of the amino-bases, though to a smaller degree than with acids. The relation of the constants evaluated (K′) to the thermodynamic dissociation constants (K) are expressed by the equation $K' = Kf_s/f_{A'}$, where f_s is the activity factor of the undissociated molecules and $f_{A'}$ that of the anion. The values of K′ for all acids are lowered by a given alcohol content by approximately the same amount. The activity factors of the undissociated molecules are seen to be lowered to a greater extent than those of the ions. This relation is in general agreement with solubility effects of the acids and bases in alcohol and in water.

J. N. P.

900. *The Electrical Conductivities of Hydrogen Chloride and Potassium Chloride in Water and Acetone-Water Mixtures.* **T. K. Brownson** and **F. M. Cray.** (Chem. Soc., J. 127. pp. 2923–2935, Dec., 1925.)—The equivalent conductivity of hydrogen chloride in acetone-water mixtures at infinite dilution falls sharply to a minimum in the solvent containing about 85 % of acetone. In other solutions, the equivalent conductivity falls as the acetone content increases. The equivalent conductivity of potassium chloride at infinite dilution falls to a well-defined minimum in the solvent containing approximately 40 % by volume of water, but at other dilutions, owing to the change in degree of dissociation of the electrolyte, this minimum shifts and in more concentrated solutions, $v = 100$ and $v = 50$, no minimum is observable in any acetone-water mixture in which the solubility of this electrolyte allows the measurements to be made. The influence of temperature upon the degree of dissociation of these electrolytes is more marked the higher the acetone content of the solvent and the higher the concentration of the solution. The Ostwald dilution law is found not to hold fully in any acetone-water mixture investigated, but as the acetone content increases this law gives values more nearly approaching a constant at all dilutions. J. N. P.

901. *Electrolytic Behaviour of Polonium and Bismuth.* **F. Paneth.** (Zeits. Elektrochem. 31. pp. 572–576; Disc., 576, Nov., 1925. Paper read before the Deut. Bunsen-Gesell., Darmstadt, May, 1925.)—Polonium in a solution of potassium hydroxide can go into solution both anodically and kathodically as shown by measurements of the radio-activity of gold anodes and kathodes covered with a layer of polonium. The kathodic solubility decreases with decreasing concentration of alkali, while the anodic solubility increases with decreasing concentration. Somewhat similar results are obtained with bismuth (thorium C) produced by radio-active disintegration, but no effects are observed with lead (thorium B). The results show a similarity between the electrolytic behaviour of polonium, bismuth and tellurium. B. W. C.

902. *The Hydrate Problem. III. Electro-endosmosis and Electrolytic Transference of Water.* **H. Remy.** (Zeits. phys. Chem. 118. pp. 161–192, Nov. 20, 1925.)—Measurements of the displacement of liquids due to the action of imposed electric potentials [see Abstract 175 (1924)] have been made with pure water and with various electrolytes of concentration from 0·001 normal to normal, diaphragms of powdered sulphur, animal

charcoal, earthenware, Zsigmondy-Bachmann membrane, gelatin and parchment paper being used. Experiments with alkali chloride and bromide solutions show that with parchment paper, gelatin and probably animal charcoal the displacement of the liquid in the direction of the positive current, calculated for equal quantities of electricity and for equal specific conductivities of the systems, increases with the concentration of the electrolyte. With parchment paper and gelatin such increase is conditioned, not by more intense adsorption of the anions or by increase of the electro-endosmosis, but by electrolytic transference of water. Since electro-endosmosis usually diminishes greatly as the concentration is lowered, with parchment paper, which even in high dilutions shows very slight electro-endosmosis, it is probable that the latter may be neglected in relation to the electrolytic transference of water when solutions of normal concentration are used. T. H. P.

903. *Electrolysis of Acid Solutions of Copper Sulphate.* **L. V. Redman.** (J. Phys. Chem. 29. pp. 1548–1555, Dec., 1925.)—With a view to determining the kathode conditions in electrolytic cells with $CuSO_4 . 5H_2O$ (0·8 g. and 1·6 g. respectively per litre of maximum-conducting, 7·6 N, H_2SO_4), the limiting current for H liberation is observed with current interrupted at various frequencies up to 3000 per sec. Tabulated results show that the limiting current rises continuously with the frequency of the interruptions, with a maximum equal to about double the limiting uninterrupted current. The predictions of Siegrist's theory are thus directly contradicted, the results being in quantitative accord with those of the diffusion theory. A. B. C. L.

904. *Electrolysis of Fused Electrolytes. I. The Production of Iron.* **F. Sauerwald** and **G. Neuendorff.** (Zeits. Elektrochem. 31. pp. 643–646, Dec., 1925.)—The production of iron from fused electrolytes consisting of solutions of ferric oxide in silica was investigated. The electrolysis was carried out with direct heating independent of the electrolysing current, and heating by means of the current used for electrolysis. The latter method was found to be the only one for temperatures above 1600° C. The electrolysis was found to be most efficient when the current for heating and electrolysis was the same. Carbon anodes and iron kathodes were employed. The current yield of iron was about 8·5 % of the total current employed. The iron was analysed and found to be highly pure. The results obtained show that it is possible to obtain pure iron in both the solid and molten state by the electrolysis of iron silicates. F. J. B.

905. *Formation of Amalgams of Alkali Metals by Alternating-Current Electrolysis.* **S. Bodforss.** (Zeits. Elektrochem. 31. pp. 646–649, Dec., 1925.)—When solutions of the alkaline hydrates are electrolysed with alternating current between mercury electrodes in the presence of a strong reducing agent, such as hydrazine hydrate, alkali amalgams are obtained. The current employed was 48 periods. The electrolyte was well stirred during electrolysis. In the absence of hydrazine it was not possible to detect the formation of amalgams. The powerful depolarising effect of the hydrazine hydrate is given as the explanation of the production of amalgams, by protecting the dissolved alkali metal from again becoming oxidised. F. J. B.

906. *Electrolytic Deposition of Metals. I. Theory of the Mechanism.* **P. K. Frölich** and **G. L. Clark.** (Zeits. Elektrochem. 31. pp. 649–655, Dec., 1925. From the English.)—The kathodic deposition of metals is examined theoretically. The polarisation which takes place when the metal is deposited is discussed. Kathodic deposition as an independent crystallisation is held to be untenable. The hydrogen over-voltage, its relationship to the metal deposited and the adverse influence of hydrogen upon the deposition of metals are considered. No proof can be adduced for the existence of an intermediate step in the deposition of metals. The discharge of the metal ion and the crystallisation of the liberated ion are so intimately connected that they must be considered as one process. A resistance is found to exist at the deposition of metals of the iron group, which cannot be ascribed to the specific properties of the electrolyte. A more exact examination shows that this probably accompanies the deposition of all metals and is the true over-voltage of the metals. This "true over-voltage" is highest for those metals which have the lowest "hydrogen over-voltage." The relationship between the metal and the hydrogen over-voltage appears to be extremely important for the explanation of the kathodic crystallisation of the individual metals. F. J. B.

907. *Electrolytic Deposition of Metals. II. X-Ray Examination of Electrolytic Nickel.* **G. L. Clark** and **P. K. Frölich.** (Zeits. Elektrochem. 31. pp. 655–658, Dec., 1925.)—The structure of electrolytic nickel deposited from solutions of nickel sulphate and chloride containing ammonium chloride, excess of ammonia, ammonium oxalate, and to which boric acid and gelatin were added, was examined by three different X-ray methods. (1) A spectrophotogram of nickel powder through an ordinary slit, monochromatic light from a molybdanium screen. The X-ray tube was worked with 35,000 volts and 15 milliamps. The spectrograph had a radius of 150 mm. and could be accurately measured. (2) Pin-hole photographs with K_α molybdenum rays through the sample at a distance of 3 to 5 cm. from the sensitive plate. (3) Laue photographs with ordinary rays from a tungsten disc. The tube was worked with 100,000 volts and 3 milliamps. The results showed that the favourable condition for producing a fibrous structure is low-current density. High temperature favours the formation of large grains. The hydrogen-ion concentration of the solution and the electrode potential both influence the deposit. The influence is not quantitatively determinable from the X-ray diagram. The evolution of hydrogen prevents the regular arrangement of grains. The presence of organic material in the precipitate did not cause any disturbance in the regular deposition of the metal. The X-ray results support the view that the discharge of the nickel ion and the deposition of the metal take place simultaneously. Owing to the instability of the hydride in solid solution the X-ray investigation does not furnish a proof of the formation of the hydride.
F. J. B.